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GENERAL FISHERIES COUNCIL FOR THE MEDITERRANEAN
CONSEIL GÉNÉRAL DES PÊCHES POUR LA MÉDITERRANÉE

Report of the second

TECHNICAL CONSULTATION ON STOCK ASSESSMENT IN THE EASTERN MEDITERRANEAN

Athens, Greece, 28 March - 1 April 1988

Rapport de la deuxième

CONSULTATION TECHNIQUE SUR L'ÉVALUATION DES STOCKS DANS LA MÉDITERRANÉE ORIENTALE

Athènes, Grèce, 28 mars - 1er avril 1988

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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GENERAL FISHERIES COUNCIL FOR THE MEDITERRANEAN
CONSEIL GENERAL DES PECHES POUR LA MEDITERRANEE

REPORT OF THE SECOND TECHNICAL CONSULTATION ON STOCK ASSESSMENT IN THE EASTERN MEDITERRANEAN

Athens, Greece, 28 March - 1 April 1988

RAPPORT DE LA DEUXIEME CONSULTATION TECHNIQUE SUR L'EVALUATION DES STOCKS DANS LA MEDITERRANEE ORIENTALE

Athènes, Grèce, 28 mars - 1er avril 1988

Edited by/Edité par

M. Savini and/et J.F. Caddy

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
Rome 1989

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PREPARATION OF THIS DOCUMENT

The present document is the final version of the Report adopted on 1 April 1988 by the General Fisheries Council for the Mediterranean member nations participating in the Second Technical Consultation on Stock Assessment in the Eastern Mediterranean.

The references in the appendixes are as presented by the authors.

PREPARATION DU PRESENT RAPPORT

Le présent texte constitue la version définitive du rapport que les pays membres du Conseil général des pêches pour la Méditerranée participant à la deuxième Consultation technique sur l'évaluation des stocks dans la Méditerranée orientale ont approuvé, le 1er avril 1988.

Les références des annexes sont telles que présentées par les auteurs.

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ABSTRACT

The second Technical Consultation on Stock Assessment in the Eastern Mediterranean of the General Fisheries Council for the Mediterranean (GFCM) was held in Athens, Greece, from 28 March to 1 April 1988. It reviewed the status of national fisheries, of marine resources research and of statistical collection. It considered the progress made in implementing the recommendations of the first Technical Consultation. It also discussed the field programmes and surveys and the progress made in the application of stock assessment to resources management. It formulated several recommendations on research and management.

RESUME

La deuxième Consultation technique sur l'évaluation des stocks dans la Méditerranée orientale du Conseil général des pêches pour la Méditerranée (CGPM) s'est tenue à Athènes, Grèce, du 28 mars au 1er avril 1988. Elle a passé en revue la situation des pêches nationales, l'état de la recherche sur les ressources marines et la collecte de statistiques des pêches. Elle a considéré les progrès effectués dans la mise en oeuvre des recommandations de la première Consultation technique. Les programmes de terrain et prospections, et les progrès accomplis dans l'application de l'évaluation des stocks pour l'aménagement des ressources ont également été discutés. La Consultation a formulé diverses recommandations en matière de recherche et d'aménagement.

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I. OPENING OF THE CONSULTATION

1. The Second GFCM Technical Consultation on Stock Assessment in the Eastern Mediterranean was held in the Hotel Chandris in Athens, Greece, from 28 March to 1 April 1988. It was attended by 27 participants from 4 GFCM member nations, and the European Economic Community. The list of participants is given in Appendix B to this report.

2. Mr M. Savini, Secretary of GFCM, welcomed the participants on behalf of FAO. He noted that international cooperation was for the time being more developed in the western part of the Mediterranean than in the eastern part and stressed the need for more frequent contacts among fisheries scientists from all countries of this sub-region.

3. On behalf of the Minister of Agriculture of Greece, Mrs P. Sidira, Executive Secretary (Fisheries and Aquaculture), Ministry of Agriculture, officially opened the Consultation. In her address she mentioned that since a few years Greek researchers attached a growing importance to stock assessment in view of the rational management of fishery resources. She commended the effort of GFCM in this respect and wished every success to the Consultation.

II. ADOPTION OF THE AGENDA

4. The Consultation adopted the agenda as shown in Appendix A to this Report. The documents submitted to the Consultation are listed in Appendix C.

III. ELECTION OF OFFICERS

5. Mr N. Tsimenides (Greece) was elected Chairman of the Consultation and Mr R. Livadas (Cyprus), Vice-Chairman.

IV. STATUS OF NATIONAL FISHERIES, NEW DEVELOPMENTS IN THE FISHERIES SECTOR AND NEW FISHERIES REGULATIONS INTRODUCED

6. The Chairman introduced this item with general remarks on the need for collaborative effort in research on shared resources in the Eastern Mediterranean, indicating that although the swordfish, tuna and some small pelagic resources are almost certainly shared, we know very little about their stock units and dynamics. Even for demersal resources, which may more likely be found solely in waters under national jurisdiction, it is important to see to what extent a common policy is possible in managing resources.

7. National representatives then provided a brief account of recent events in the national sector since the first Consultation.

A. Recent Developments in the Fisheries Sector

Cyprus

8. Very few new developments could be reported. In summary, for the small pelagic resources, though resources exist, and vessels brought from Greece have attempted exploitation, the gear, vessels and fishing techniques do not exist in Cyprus to exploit them. For the demersals, the catch by trawlers and inshore vessels is increasing continuously from year to year. Squid and octopus are plentiful in the trawl catch, but no other invertebrates.

Egypt

9. Approximately 11 percent of the national fish harvest, of some 227 000 t (freshwater and marine) is from the Mediterranean. In 1983, the Government enacted a new legislation governing cooperatives and also marine and inland fisheries. Developments in the sector come under the 1987-92 five year plan. This attempt to increase efficiency of use of existing resources is based on the need to keep up with a 2.3 percent population increase per year and is hoped to provide 700 000 t of fish by year 2000 to meet protein needs for a population anticipated at some 70 million by that time. Intensification of fish farming will be a major methodology.

10. In the marine sector, an attempt is being made to strengthen extension activities to a fleet consisting of some 1 500 vessels between 10 and 400 hp, plus some 800 sailing boats. These efforts are mainly aimed at upgrading engines/vessels to 200-300 hp, in order to encourage exploitation of grounds further from the coast in greater depths, using echosounders and mechanized systems purchased with government loans, provided through fishermen's cooperatives.

11. Prior to the construction of the Aswan Dam, sardine production was some 18 000 t off the Mediterranean coast, but dropped to 2 000 t in 1967. Recently, it has started to increase again, as the low of drainage water from irrigation, rich in nutrients, has reached the delta. By 1987,

sardine landings were estimated at some 7 000 t, with 2 000 t of Boops boops, some 1 000 t of demersals, and over 2 000 t of shrimp (penaeids).

Greece

12. Marine fisheries in Greece make up only 0.31 percent of the GNP, and 2 percent of the revenues from the agriculture and fisheries sectors combined. However, the sector is considered important, and employs some 39 000 fishermen. Sixty percent of the fleet are less than 15 years old, and consist of some 20 228 vessels, totalling some 124 300 t. Ninety seven percent of the fleet are coastal vessels; mainly longliners, gillnetters and small trawlers. A few distant water vessels fish in the Atlantic but 90-95 percent of catches come from the Mediterranean. Licences are strictly controlled and are usually only issued on retiring of an existing vessel; however, the number of persons involved in the fishery in recent years has grown, since recent restrictions on amateur fishermen have led to many becoming professional fishermen. Some increase in effort has occurred in recent years in Greek waters due to increases in fleet horse power; landings have also increased, as well as the value of the catch. Some 60 000 t of fish were imported to cover unsatisfied demand in 1986, and only some 14 000 t exported.

(a) Small Pelagic Fish

13. Reference was made to the policy of the European Economic Community aimed at stabilizing fish prices in Greece, which differ widely from port to port and season to season. In particular, an attempt is being made to encourage processing of sardine and anchovy.

(b) Large Pelagic Fish

14. Since the 1960s, an attempt has been made to develop swordfish, bluefin and albacore resources, and the combined catch is currently 2 300 t. There is not much information currently on catch rates but research is now being carried out jointly with Italian scientists. Current interest by Japan in bluefin is encouraging price increases which have been generally low in the sector. Clearly, there is a need for a common framework for tackling large pelagic fish management. The Secretariat recalled that ICCAT (International Commission for the Conservation of Atlantic Tunas) had been given management responsibilities not only for the Atlantic but also for adjacent seas such as the Meiterranean. It was felt however that GFCM could play a role, in cooperation with ICCAT, in bringing together all interested countries, especially those which are not member of ICCAT. The EEC representative noted that once the Protocol amending the ICCAT Convention to make possible full EEC membership is ratified by all ICCAT member countries, Greece and Italy would be represented in ICCAT together with other EEC members, by the EEC; for that reason, both countries should be prepared to submit to the EEC the adequate data.

15. Subject to official confirmation, Greece would be prepared to host a Mediterranean meeting on large pelagic fish stocks.

(c) Demersals and Invertebrates

16. Forty percent of Greek production consists of demersals, especially hake, red pandora and red mullet. In general, overfishing is more serious in bays and nearer the larger ports where prices of fish are higher, and the main trawl resources are in the Northern Aegean Sea. This situation also applies to Nephrops and penaeid shrimp. At present, exploitation of bivalves is not intense and occurs mainly in the Thermikos Gulf.

(d) Mesh Size Regulations

17. With respect to the 40 mm GFCM recommendation, fishermen in Greece and also in other countries are still negative on its application. Further research on its impact will be needed. The same problem occurs as with other Eastern Mediterranean countries; i.e., the existence of local fisheries for small species, and the fact that for some countries (e.g., Cyprus), the fishery is heavily dependent on very small species (e.g., Spicara smaris).

Israel[1/]

18. In the inshore Israeli fishery which is carried out by small boats, the present development tendency is toward bigger boats with more powerful engines. The number of boats in this sector is

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1/ No Israeli delegate attended the Consultation but a document entitled "The state of the Israeli Mediterranean fishery" was received. The Consultation agreed that its own report could take into account the content of the Israeli contribution

steadily increasing, and administrative measures to limit their number may have to be considered in the near future.

19. The number of vessels engaged in the pelagic fishery is decreasing mainly because of the low price and the lack of demand for pelagic fish.

20. A new development in the trawl fishery is the introduction of the so-called "mini-trawlers" 10-12 m long, fishing for shrimp in shallow waters near the shore. The number of trawlers increased by some 60 percent over the last three years. This was made possible by the expansion of the fishing effort over new fishing grounds located by the extensive use of advanced electronic devices and by the diversification and improvement in fishing gear design.

B. Sponge Disease

21. Greek production of sponges dropped after 1986, from a figure of around 30-35 t to 10 t in 1987. According to preliminary research results, a fungus disease is considered responsible. The Egyptian delegate also reported a decline from 8 to 4 t in 1987 for a similar reason. The Technical Secretary mentioned that a similar disease had recently led to the closure of the sponge fishery in Tunisia, and that GFCM had been approached by Turkish fishery authorities with the request that a special meeting be held on this topic. The Greek delegation reported that they were discussing cooperative action on this problem with Turkey. The fact that sponges below 60 m are not so far affected might suggest that other factors than just a fungal infection are involved.

C. Fishery Regulations

Cyprus

22. There continues to be a closed season for trawling from 1 June to 31 October, and a minimum depth of 30 m for trawling is imposed, plus an upper limit of 250 hp on engine size. A mesh size minimum of not below 34 mm is checked by fisheries inspectors using the ICES (International Council for the Exploration of the Sea) gauge.

Egypt

23. It has proved impossible so far to persuade fishermen to move to a larger mesh size. A presidential decree will soon prohibit trawling from 15 June to 15 September.

Greece

24. The following regulations are currently in force:

(i) vessel licensing: there is a limited entry to the fishery (no increase of total tonnage allowed);

(ii) trawlers: a closed season on trawling extends from 1 June to 30 September, minimum mesh size (cod end) is 28 mm (stretched mesh); fishing is prohibited inside one mile or, in some cases, inside two miles of the coasts; many gulfs and bays are closed to trawling;

(iii) beach seiners: a closed season runs from 1 June to 30 September;

- minimum mesh size 16 mm (stretched),
- the seiner boat must go no more than 70 m from the beach,
- many gulfs and bays are closed,
- no fishing is allowed at night,
- no new entries are permitted;

(iv) purse seiners: it is prohibited to fish inside 100 m of the coast and in less than 30 m depth: (a) night fishing: minimum mesh size 14 mm, (b) day time fishing: minimum mesh size 40 mm;

(v) swordfish: fishing is prohibited from 1 October to 13 January;

(vi) no trawling is allowed inside 3 miles of river estuaries;

(vii) fish size: in general, it is prohibited to land fish of less than 8 to 16 cm according to species.

25. Size limits in Greek waters are as follows:

Mullus barbatus Mullus surmuletus Pagellus erythrinus Boops boops Alosa falax nilotica	10 cm
Scomber scomber Scomber japonicus collias Teuchurus sp.	12 cm
Solea sp. Lichia amia Spaeus duratus	14 cm
Dicentra rehus sp. Mugil cephaleu	16 cm

26. In recent years, permits for amateurs and professional boats have been renewed every two years and an up-to-date vessel registry is maintained. Fishing permits for amateurs have been restricted in recent years. A presidential decree is imminent which will define a legal framework for vessel licensing and the right to fish.

Israel

27. The following regulations on minimum mesh and fish size are presently enforced:

- cod end of trawls of any type	48 mm
- purse seines	20 mm

Minimum fish sizes

Sardines of any kind	11 cm
Mullidae	11 cm
Boops boops	11 cm
Saurida undosquamis	12 cm
Pagellus erythrinus	12 cm
All other commercially important species	20 cm

28. The rapid development of the inshore and trawl fishery and the appearance of the so-called "mini-trawlers" made it necessary to legislate and enforce additional management measures. Thus an exclusive area for the setting of entangling gear was established and trawling in this area prohibited. Furthermore legislation was promulgated giving authority to the Fishery Administration to limit entries into the different fishery sectors of additional fishing crafts, to impose certain restrictions on size and type of fishing gear and to establish closed or restricted fishing areas or seasons. Most of these regulations are not yet enforced and much more monitoring of fishing effort and of the fish resources will be needed to make them applicable.

V. STATUS OF MARINE RESOURCES RESEARCH

Cyprus

29. The Department of Fisheries of the Ministry of Agriculture and Natural Resources is responsible for research. Data are collected on length frequency and catch composition by research vessels, but also at sea on commercial trawlers. The objective is a better knowledge of the population dynamics of demersal stocks.

Egypt

30. The Institute of Oceanography and Fisheries of Alexandria is the main research organization for Mediterranean fisheries; often working in cooperation with the Faculty of Sciences of Alexandria University, the National Planning Institute and the Faculty of Agriculture.

31. Earlier Egyptian research on Mediterranean stocks was carried out jointly with the USSR in 1970-71, and more recently with Italy in 1983. This latter was a survey to 600 m with different types of trawl gear.

32. Research is also being carried out in aquaculture (e.g., on the collection of mullet fry for restocking coastal lagoons), and is mentioned in more detail in Ettewa's paper (Appendix R, this report). Lagoon fishery development is a priority and for the Bardowil lagoon is being carried out under an EEC grant.

Greece

33. The Ministry of Industry, Energy and Technology maintains two Fisheries Research Institutions; the National Center for Marine Research in Athens and the Institute of Marine Biology in Crete. Fishery research is also being carried out by the Fisheries Laboratory in Piraeus under the Ministry of Agriculture. On the other hand marine research is being conducted by various teams in the Biology Departments of Thessaloniki, Athens, Patra and Crete. Scientists in all of the above Institutions are grouped into functional units for particular investigations.

34. In general the National Center for Marine Research is mainly focusing on studies of the dynamics of demersal stocks of commercially important fish, such as hake, striped mullet, red mullet, common pandora and poutassou. Presently, a project on pelagic resource investigation by acoustic methods is being prepared. On the other hand, the Institute of Marine Biology of Crete is focusing the appraisal on pelagic fishery resources by means of hydroacoustics, and on food chain studies. Aspects of the dynamics mainly of demersal resources are also being studied by the Fisheries Laboratory. The Institute of Marine Biology of Crete (IMBC) is a special case of University and research institute collaboration. It is an independent institution affiliated with the University of Crete. It has been established to promote a coordinated marine research effort within the University environment. The symbiotic functioning of the IMBC and the University of Crete has proved mutually beneficial. The IMBC contributes to the upgrading of under-graduate studies and supports a graduate programme in Marine Research at the University of Crete. It solves many operational problems because of its flexible non-bureaucratic procedures facilitated by its independent legal status. Conversely, the University of Crete has served as a pool of scientific personnel for the IMBC and has provided the academic setting for the graduate programme.

35. Two research vessels are available for marine and fisheries research. The largest one (AEGAION) of 52 m long is owned by the National Center for Marine Research and the smaller one (PHILIA) of 27 m long is owned by the Institute of Marine Biology of Crete. Both of these are trawlers with facilities for fisheries research.

36. In addition to these main institutions working on fisheries research projects, the pre-mentioned various teams at the Universities investigate topics of special interest for each University. For instance, the fishery research team at the University of Thessaloniki works on ecology and systematics of the Aegean selachii; gonad maturation and annual cycle of spawning of the most commercially important fish; estimates of heavy metals in some fish from polluted areas, etc. At the University of Athens there are projects on hand concerning plankton and benthos, while studies on fish eggs and larval identification, growth rates and food of dominant fish larvae, and assessment of fish spawning areas, are some of the main topics investigated by the fisheries team at the University of Patra.

37. In recent years, fishery research in Greece has been given more emphasis. This development in fishery research has partially been supported by funding from the EEC and other international organizations. Within the framework of the integrated Mediterranean project it is planned to establish two new fisheries research centres and build a new research vessel.

38. Greek tuna fisheries have been known from classical times, but tunas have never been a large component of the fishery. With purchase by Japanese buyers, fishing areas are expanding from current very limited geographic areas. Effort and catch data are now being collected on bluefin tuna fisheries (see paper by Lefkaditou, Megalofonou, Tsimenides and De Metrio, in Appendix Q of this report), on other tunas, and swordfish.

Israel

39. In Israel, research is presently concentrated on: (i) the monitoring of the fishing effort, (ii) trawl gear study and (iii) experimental long lining.

40. The EEC representative noted that in 1987, EEC adopted a Regulation for coordination of fisheries research in the EEC, with a programme of five year duration, and a funding of 30 million ECUs.

VI. STATUS OF STATISTICAL COLLECTION IN THE FISHERIES SECTOR

A. Types of Data Collected

Cyprus

41. Catch and effort data are collected regularly by the trawl fleet for demersals. Data on commercial catches are collected by district officers in the main towns; in addition, all trawlers skippers complete log books. Data from the inshore fishery is collected monthly, and total statistics estimated by weighting up to the whole catch.

42. Biological sampling of trawlers is carried out at sea: small-scale boats in port. Trawl catches are sampled for size frequency by species as well as maturity stages.

Egypt

43. The Institute of Oceanography and Fisheries in Alexandria has catch sampling schemes in the main ports.

Greece

44. After the Second World War, most of the Greek seine fleet had to be re-constructed, and by 1948 already numbered 220 vessels. Fleet increase slowed down in the late 1970s to reach 376 vessels in 1986. However, average fleet horse power has continued to increase, from 49 hp in 1948 to reach 207 hp in 1986 (see paper by Tsimenides, Appendix N of this report). A similar evolution applies for the trawl fisheries.

45. Various authorities are involved in collecting fisheries data in Greece; principally, the National Statistical Office, the Fisheries Department and the Agricultural Bank of Greece; each having somewhat different priorities for type of data collected.

46. An archive of data is maintained on the fleet size of vessels over 20 hp, which is used in relation to limited licensing. Data on catches and prices by sector are also collected regularly, and transmitted from regional centres and port authorities to the National Statistical Office.

Israel

47. Data on the inshore and pelagic fisheries are collected in the main harbours (see national report by Grofit, Appendix T, this report) and manpower constraints affect the reliability of this data. Effort data is rather well represented through a regular daily vessel radio reporting system, though gear/vessel types are not fully defined. An overal statistical bulletin is published in English and Hebrew.

B. Progress Achieved in Construction of Fisheries Data Bases, Computerization and Reporting

48. In Cyprus, Egypt, Greece and Israel, statistical data are now being stored on computers. In Egypt, the Organization for Fisheries Resources Development installed 2 IBM compatible micro-computers in 1987 for this purpose. Data are compiled on vessels, hp gear type and total catch (not by species). From 1988 onward, the staff will be trained to break down catch by main species and sizes.

49. In Greece, a semi autonomous Government corporation, the Etanal Company, is responsible for storing fisheries data and has developed a four year Electric Data Processing (EDP) programme to manage data on catches. The programme so far is centred on the main port of Piraeus which receives some 50 percent of the catches from the seven official landing ports. Catches by quantity and value are collected daily, and a monthly statistical bulletin issued. The objective is to extend this data base to the other official fish ports, and to connect Etanal to the regional centres.

50. Collecting correct primary data and coding it by species/names is essential, and a Greek species coding exercise is now under way. The Technical Secretary suggested contacting Dr W. Fischer of FAO who is developing a similar standard data base founded on the new Mediterranean Fish Identification Sheets. This suggestion was agreed to by the Greek delegation.

51. The Egyptian delegate referred to the need to train national officers in data collecting procedures, and suggested that a training course for Eastern Mediterranean fisheries workers in this topic was very desirable. This suggestion was supported by the Greek delegation.

Fishing effort data

52. In relation to national reporting, all countries issue annual bulletins of catches, but the use of standard effort units as recommended in paragraph 55 of the last Consultation has not yet been implemented.

53. The Greek delegation reported problems in standardizing fishing effort data, though this information is now being collected by port for the small pelagics, and some work has now started on the large pelagics. In this area the University of Crete is beginning a data base on effort; especially for sardine and anchovy fisheries. The Government is concentrating most of its efforts in this sector on trawl fishing and beach seining.

54. The Technical Secretary referred to the need to monitor changes in catch rate by vessel type, and to use catch rate to calibrate each vessel class against the standard before estimating total fishing effort in standard units.

VII. FIELD PROGRAMMES AND SURVEYS, INCLUDING STATUS OF ACOUSTIC, DEMERSAL AND PRE-RECRUIT SURVEYS

(a) Acoustic Surveys

55. No recent acoustic surveys have been carried out by Cyprus, and Egyptian experience was confined to the Egyptian-Italian cooperation programme mentioned earlier.

56. In Greece, an acoustic survey programme financially aided by the Ministry of Agriculture, started in 1978 and was finally implemented in 1984 by the Institute of Marine Biology of Crete. The main objectives are:

- to estimate abundance and find out about vertical migration of small pelagic stocks;
- to determine what environmental factors determine stock distribution.

57. Two vessels are currently available, both equipped with sonar:

- RV PHILIA - 27 m, from the Institute of Marine Biology of Crete, equipped with 2 EK 400 Simrad 120 + 38 KH units with colour display, and
- RV AEGAION - 52 m, belonging to the National Center for Marine Research, with sonar, similar instrumentation which is coming into use shortly.

58. The PHILIA has already completed a series of surveys in the Northern Aegean Sea, and this year will be in the middle Aegean, as well as repeating some stations from last year.

59. Data on pelagic fish abundance is being collected in up to 10 depth strata and stored on computer for analysis and mapping.

60. In addition to sonar data, sampling is carried out with a semi-pelagic trawl, and compared with commercial catches. Temperature, salinity and oxygen profiles are being carried out at each station.

61. The need to verify the real situation with respect to the so-called sardine-anchovy cycle of dominance will be tackled by long term sonar studies, but also through an EEC contract with the University of Crete and the Pan-Hellenic Union of Agriculture Cooperative jointly with the Imperial College, London, to analyse Greek data. The Consultation suggested that GFCM be kept informed of the results of this study.

(b) Trawl Surveys, Including Juvenile Surveys

62. The Cyprus Department of Fisheries is carrying out research vessel trawl surveys, mainly aimed at localizing spawning areas and times for demersals. This year, a 2-3 year stock identification programme also started which will help with management measures. It is also planned to carry out a pre-recruit survey in October before the November trawling season opens, to estimate stock size, by using a small mesh cod end of 8 mm.

63. The Greek National Center for Marine Research is carrying out surveys of particular areas and resources each year; for example, on hake, mullets, Nephrops and red pandora. The trawl surveys are conducted in various areas according to the national priorities for fishery management. During surveys, sampling is carried out on a pre-selected grid of stations repeated seasonally over the period of the project. However, the surveys do not apparently constitute a standard cruise track or random sampling design for the whole area, repeated annually. Commercial trawlers are also used for survey purposes. So far, the areas of Saronikos, Patraikos, Korinthiakos, Eubiokos, Pagassitikos

and Thermaikos gulfs as well as the Thracian and Ionian seas have been investigated. More recently, new survey programmes have included comparative study of fished and unfished areas, and first approaches to egg and larval studies have been made. With a much longer research history, considerable research effort has been expended in Greece on food and feeding studies of marine fish.

(c) Research Survey Design

64. Evidently, the needs for fisheries management to some extent dictate the survey objectives and design to be followed. As noted in the document presented by the Technical Secretary, if management by quotas is the intention, then a biomass survey covering the whole area of the stock and a real time and comprehensive sampling system will be essential. If however, the main purpose of research surveys is to provide a time series of abundance (cpue) trends, especially for the juveniles, indicative sampling of the more productive grounds and coastal nursery areas, carried out on an annual basis will be adequate (this could be complemented by a total biomass estimate at intervals of several years, if necessary, without losing the continuity of sampling).

65. Assuming that management by quota is not envisaged, such an annual series of estimates giving trends in recruitment for the main species can be used in a Thompson-Bell yield evaluation to predict trends in the fishery in the coming year, and to establish possible effects of fishing seasons and fishing strategy or other human impacts (such as coastal pollution), on the resource.

(d) Large Pelagics

66. Seventy five fleets fish swordfish in Greek waters with a total of 334 boats and a preliminary survey of this sector is reported on by De Metrio, Megalofonou, Tselas and Tsimenides (Appendix O, this report). Most reproduction appears to be in July and August, and a wide range of catch size distribution is shown by the various fleets. Although the population dynamics of this species remains to be established, it is clear that a common policy for exploitation is needed within the region.

VIII. STATUS OF FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL MONITORING AND DATA COLLECTION OF RELEVANCE TO FISHERIES

67. A major cooperative oceanographic programme is now under way in the Eastern Mediterranean, including 8 countries and several regional and external institutes. POEM (Physical Oceanography of the Eastern Mediterranean) has revealed several features of relevance to fisheries and raised a number of questions.

68. In April through the summer to october, there is persistent upwelling along the Eastern boundary of the Aegean, but this is not associated with a major primary production input to food webs. Presumably this would suggest that bottom water is also low in nutrients, confirming the essentially oligotrophic nature of the area compared with, for example, the Adriatic Sea. Nutrient levels in general are between a fifth and a twentieth of other areas of the Mediterranean such as the Ionian Sea (see Friligos for details, Appendix V of this report).

69. Two other aspects of relevance were reported here: essentially the Aegean bottom water is largely separated from the rest of the Mediterranean bottom water, and also receives surface water from the Dardanelles. Also, a degree of eutrophy is apparent for near shore areas, bays and gulfs near main coastal areas (see Friligos' papers, Appendixes V and Y of this report).

70. It is to be hoped that further information for example, on cyclonic and anticyclonic structures mentioned in the area, will assist in studies on stock structure of small pelagic resources, and of swordfish, which are usually associated in their distribution with marine fronts.

IX. PROGRESS IN THE APPLICATION OF STOCK ASSESSMENT TO RESOURCE MANAGEMENT

71. A number of new, and in many cases, preliminary assessments of fish resources were presented at the Consultation, in particular on:

- Spicara smaris (by Tsangridis and Filippoussis, Appendix K),
- Mullus barbatus (by Karlou and Vrantzas, Appendix D and by Livadas Appendix E,
- Pagrus pagrus (by Vassilopoulou, Appendix L),
- Pagellus erythrinus (by Mytilineou, Appendix H),
- Boops boops (by Livadas, Appendix F),
- Micromesistius poutassou (by Papaconstantinou and Petrakis, Appendix I).

72. Discussion of these preliminary assessments tended to focus on the likely input of variations in parameter values on the assessments themselves. A common problem (shared with workers from elsewhere in the Mediterranean) is the degree of uncertainty with respect to values of von Bertalanffy growth factor K, which is used directly as an input to either the Beverton and Holt

yield per recruit calculation, or in estimating M, selectivity, and Z (from length-converted catch curves), in the Pauly and Wetherall methods. The main problem with the growth estimates appears to be that mentioned in paragraph 56 of the report of the first Consulation, namely, low predicted values of K, and very low negative values of t_o.

73. It appears that this is in part a consequence of existing methods of fitting the growth curve, but much more important, the general absence of data on size at age of fish for the first year of life.

74. As noted in paragraph 61 of the first Consultation, the importance of properly defining growth rate in the first two years is evident. The mean size at age (in these early years) should probably be followed at quarter year intervals.

75. Using size at age data during the first six months of life will certainly constrain the growth curve to pass close to the origin. In the absence of such data it would still be instructive to see what values of K would be obtained if the growth curve is made to pass close to the origin. These values should at least be indicative of the possible range in values of K, and could provide a likely set of parameters input to a range of estimates of the state of stock exploitation, that would be more likely to include the actual situation. Some further comments on this question based on subsequent analyses are appended (see Appendixes M, W and X by Caddy).

76. The document presented by the Technical Secretary placed high priority on filling gaps in the data, and resolving important problems during the first year of life, especially for demersal species. Almost 1/3 of the total size range of growth for most demersal species is accomplished in the nursery areas which are presumably in shallow water close to the coast. There seem to be an almost total absence of data on demersals in the commercial catch below 100 mm length, which incidentally suggests that governmental strategy to ban trawling in these areas is being at least as effective in reducing small fish catch as a larger mesh size would be.

77. The possible strategy for investigating a mesh size regulation was discussed and it was concluded that:

- The impact of a mesh size regulation would need to be tested experimentally in a limited area before being introduced throughout the fishery, in order to convince fishermen of its likely impact.

- Given the rapid growth rate in the early part of the life history when partial retention by (say) 28 mm mesh applies, the period of short-term losses in yield would be limited in duration, and certainly less than one year.

- Introducing a new mesh size following a closed season to allow juvenile fish to reach the required size for retention by the new mesh would be the best strategy.

- Clearly, a good knowledge of recruitment and juvenile growth rates is an essential pre-requisite.

- The need to control effort levels in conjunction with mesh size increases will avoid nullifying their impact by overfishing.

X. RECOMMENDATIONS IN MATTERS OF RESEARCH AND MANAGEMENT, AND ON POSSIBLE COOPERATIVE PROGRAMMES

Research

78. The Consultation agreed that priority should be given to a study of the first year of the life cycle for demersal fish resources, in order to improve estimates of early growth, and to develop indices of recruitment.

79. Given the particular life histories and habitats of Mediterranean demersal fish, general caution was expressed with using methods of parameter estimation which depend solely on statistical correlations from other areas (e.g., the Pauly formulation for M). An attempt should be made to assess M directly; e.g., from sequential abundance estimates of juveniles in coastal areas, and from studies in areas closed to fishing (catch curve analysis of age compositions).

Large Pelagics

80. Noting with concern the lack of comprehensive data about the status of large pelagics in the whole Mediterranean area, and bearing in mind that only three Mediterranean coastal countries are members of ICCAT, the Consultation felt that GFCM should take some steps to assess the status of these stocks. It welcomed the offer made by the Greek delegation to support the organization of a technical consultation on this subject, and requested the Secretariat to make sure that ICCAT and

its member countries fishing for tuna in the Mediterranean will be closely involved in such a meeting.

Training in Biological Sampling for Fisheries Statistical Officers

81. The Consultation stressed the need for a training course to be held in the Eastern Mediterranean in order to train national officers in:

- statistical design criteria for biological sampling,
- procedures for sampling in port,
- EDP procedures for storage and sorting of data on a micro-computer.

82. The course should be held in a fish port in the Mediterranean area where sampling is routinely carried out, to allow different field procedures to be tested.

Sponge Disease

83. In view of the very alarming progression of the disease affecting Mediterranean sponges, the Consultation agreed that a cooperative research programme should be launched as soon as possible. It should involve not only Eastern Mediterranean countries, but also other countries in the waters of which the disease is present. As a first step, the Secretariat was requested to contact member countries and to start gathering and disseminating available information on the phenomenon. Meanwhile, member countries will ascertain the possibility of benefitting from the FAO Technical Cooperation Programme. If such a support is granted, a Consultant should be recruited to elaborate a detailed research programme, to coordinate the activities of national research institutes in the implementation of the Programme, and to organize a meeting which would attempt to tackle the problem. It was suggested that the question be placed on the agenda of the next session of GFCM.

Mesh Size

84. The attention of the Consultation was drawn to a recommendation formulated by the Fifth Technical Consultation on Stock Assessment in the Balearic and Gulf of Lions Statistical Divisions aimed at the adoption by GFCM of a potentially binding recommendation on trawl mesh size. The Consultation agreed that an increase of the size of the mesh currently used would be beneficial for the Eastern Mediterranean fishery provided it is complemented at the national level by other suitable regulatory measures such as a closed season, a closed area and/or reduction of the fishing effort. It was stressed however that the strong resistance of fishermen to any change in the mesh size presently used would raise very serious practical problems for implementing any binding recommendation in several countries of the sub-region.

XI. ANY OTHER MATTERS

85. No other matter was raised.

XII. DATE AND PLACE OF THE NEXT CONSULTATION

86. The Consultation agreed that the date and place of the Third Consultation should be decided by the Council at its Nineteenth Session.

XIII. ADOPTION OF THE REPORT

87. This report was adopted on 1 April 1988.

I. OUVERTURE DE LA CONSULTATION

1. La deuxième Consultation technique du CGPM sur l'évaluation des stocks de la Méditerranée orientale s'est tenue à l'hôtel Chandris à Athènes (Grèce), du 28 mars au 1er avril 1988. Y assistaient 27 participants venus de 4 pays membres du CGPM et de la Communauté économique européenne. La liste des participants est reproduite à l'annexe B du présent rapport.

2. Monsieur M. Savini, Secrétaire du CGPM, a souhaité, au nom de la FAO, la bienvenue aux participants. Il a fait observer que la coopération internationale est, à l'heure actuelle, plus développée dans l'ouest que dans l'est de la Méditerranée et a souligné la nécessité de contacts plus fréquents entre les halieutistes de tous les pays de cette sous-région.

3. Au nom du Ministre de l'agriculture de Grèce, Mme P. Sidira, Secrétaire exécutif (pêches et aquaculture) au Ministère de l'agriculture, a officiellement ouvert la Consultation. Dans son allocution, elle a rappelé que depuis quelques années, déjà, les chercheurs grecs attachent une importance croissante à l'évaluation des stocks en vue d'un aménagement rationnel des ressources halieutiques. Elle s'est félicitée des efforts accomplis à cet égard par la CGPM et a souhaité un plein succès à la Consultation.

II. ADOPTION DE L'ORDRE DU JOUR

4. La Consultation a adopté l'ordre du jour reproduit à l'annexe A du présent rapport. La liste des documents soumis à la Consultation figure à l'annexe C.

III. ELECTION DU BUREAU

5. Monsieur N. Tsimenides (Grèce) a été élu Président de la Consultation, et M. R. Livadas (Chypre) Vice-Président.

IV. SITUATION DES PECHES NATIONALES, FAITS NOUVEAUX INTERVENUS DANS CE SECTEUR ET NOUVELLES REGLEMENTATIONS

6. Le Président a introduit ce point de l'ordre du jour en formulant quelques remarques générales sur l'effort de collaboration qu'appellent les recherches consacrées aux ressources partagées de la Méditerranée orientale, ajoutant que, s'il est à peu près certain que l'espadon, les thonidés et certaines petites espèces pélagiques constituent effectivement des ressources partagées, on ne sait pas grand-chose des stocks eux-mêmes et de leur dynamique. Même en ce qui concerne les ressources démersales, qu'il est plus probable de trouver exclusivement dans des eaux placées sous la juridiction d'un même pays, il importe de voir dans quelle mesure il est possible d'adopter une politique d'aménagement commune.

7. Les représentants des pays ont ensuite brièvement présenté les faits intervenus dans leur secteur national depuis la première Consultation.

A. Faits intervenus récemment dans le secteur des pêches

Chypre

8. Chypre n'a eu à signaler que très peu de faits nouveaux. En résumé, pour ce qui est des petits pélagiques, il existe certes des ressources et quelques navires venus de Grèce ont tenté de les exploiter, mais Chypre ne possède pas les engins, les navires et les techniques de pêche nécessaires pour le faire. En ce qui concerne les espèces démersales, les captures des chalutiers et des navires côtiers augmentent régulièrement d'année en année. Les encornets et les poulpes figurent en abondance dans les captures des chalutiers, à l'exclusion d'autres invertébrés.

Egypte

9. Approximativement 11 % des prises nationales de poisson, qui sont de quelque 227 000 t (poissons d'eau douce et poissons de mer) proviennent de la Méditerranée. En 1983, le gouvernement a adopté une nouvelle législation régissant d'une part les coopératives et d'autre part les pêches maritimes et continentales. Les développements qui ont caractérisé ce secteur s'inscrivent dans le cadre du plan quinquennal 1987-92. Les efforts faits en vue d'utiliser plus efficacement les ressources existantes répondent à la nécessité de faire face à un accroissement démographique de 2,3 % par an et devraient assurer, à l'horizon 2000, les 700 000 t annuelles nécessaires pour couvrir es besoins protéiques d'une population qui, à cette date, devrait atteindre environ 70 millions d'habitants. L'intensification de la pisciculture sera l'une des principales méthodes employées pour y parvenir.

10. Dans le secteur maritime, l'Egypte s'efforce actuellement de renforcer les activités qu'elle consacre à une flottille de quelque 1 500 unités de 10 à 400 ch, auxquelles il faut ajouter environ 800 navires à voile. Ces efforts visent principalement à porter la puissance des moteurs à 200-300 ch afin d'encourager l'exploitation de fonds plus éloignés de la côte et situés à de plus grandes profondeurs, moyennant l'emploi d'échosondeurs et d'appareillages mécanisés achetés avec des prêts octroyés par l'Etat à travers les coopératives de pêcheurs.

11. Avant la construction du barrage d'Assouan, la production de sardine, qui atteignait environ 18 000 t au large des côtes de la Méditerranée, est tombée à 2 000 t en 1967. Récemment, elle a commencé à remonter quand les eaux de drainage de l'irrigation, donc riches en éléments nutritifs, ont atteint le delta. En 1987, les débarquements de sardines ont été estimés à quelque 7 000 t, dont 2 000 t de Boops boops, 1 000 environ d'espèces démersales et plus de 2 000 t de crevettes (pénéides).

Grèce

12. En Grèce, les pêches maritimes ne représentent que 0,31 % du PNB et 2 % des revenus des secteurs de l'agriculture et des pêches confondus. Malgré cela, ce secteur est considéré comme important et emploie environ 39 000 pêcheurs. Soixante pour cent de la flottille a moins de 15 ans d'âge; elle comprend environ 20 228 navires totalisant quelque 124 300 t. Quatre-vingt-dix-sept pour cent de la flottille se composent de navires côtiers, essentiellement des palangriers, des bateaux utilisant des filets maillants et de petits chalutiers. Quelques navires a grand rayon d'action opèrent dans l'Atlantique, mais 90-95 % des captures proviennent de la Méditerranée. Les permis sont strictement contrôlés et ne sont généralement délivrés qu'après retrait d'un navire existant; le nombre de personnes travaillant dans la pêche a cependant augmenté ces dernières années car les récentes restrictions imposées aux pêcheurs amateurs ont amené bon nombre de ceux-ci à passer professionnels. Il s'est produit, ces dernières années, dans les eaux grecques, une certaine intensification de l'effort, qui s'explique par des accroissements de puissance (ch) de la flottille; les débarquements ont également augmenté, de même que la valeur de la capture. Quelque 60 000 t de poissons ont été importées en 1986 pour couvrir les besoins non satisfaits et 14 000 t seulement ont été exportées.

(a) Petits poissons pélagiques

13. Il a été fait référence à la politique instituée par la Communauté économique européenne en vue de régulariser les prix du poisson en Grèce; en effet ceux-ci varient considérablement d'un port à un autre et selon la saison. En particulier, on s'efforce actuellement d'encourager la transformation de la sardine et de l'anchois.

(b) Grands poissons pélagiques

14. Depuis les années 60, un effort a été fait pour mettre en valeur les ressources en espadon, thon rouge et germon, dont la capture combinée représente actuellement 2 300 t. On ne dispose pas de beaucoup de renseignements sur les taux actuels de capture, mais des recherches ont été entreprises conjointement avec des chercheurs italiens. L'intérêt actuellement manifesté par le Japon pour le thon rouge favorise une montée des prix, jusqu'ici généralement bas dans le secteur. Il est clair qu'il faut mettre en place un cadre d'action commun pour l'aménagement des grands pélagiques. Le Secrétariat a rappelé que la CICTA (Commission internationale pour la conservation des thonidés de l'Atlantique) a été chargée des questions d'aménagement non seulement pour l'Atlantique mais aussi pour les mers adjacentes, dont la Méditerranée. On a estimé toutefois que le CGPM pourrait avoir un rôle à jouer, en coopération avec la CICTA, pour mobiliser tous les pays intéressés, notamment ceux qui ne sont pas membres de la CICTA. Le représentant de la CEE a fait observer que, dès que le protocole d'amendement de la Convention de la CICTA qui doit permettre l'adhésion de la CEE à part entière, aura été ratifié par tous les pays membres de la CICTA, la Grèce et l'Italie seront représentées au sein de la CICTA au même titre que tous les autres membres de la CEE, par l'intermédiaire de cette dernière; c'est pourquoi, ces deux pays devraient se préparer à soumettre à la CEE les données appropriées.

15. Sous réserve de confirmation officielle, la Grèce pourrait accueillir une réunion méditerranéenne sur les stocks de grands pélagiques.

(c) Espèces démersales et invertébrés

16. Quarante pour cent de la production grecque se composent d'espèces démersales - merlu, pageot rouge et rouget de roche notamment. D'une manière générale, la surpêche est plus grave dans les golfes et près des grands ports, où les prix de poisson sont plus élevés, tandis que les principales ressources chalutables se trouvent dans le nord de la mer Egée. La situation est la même pour Nephrops et pour la crevette pénéide. A l'heure actuelle, l'exploitation des bivalves, qui n'est pas intensive, se situe principalement dans le golfe de Thermikos.

(d) Réglementation du maillage

17. En ce qui concerne la recommandation du CGPM préconisant une maille de 40 mm, les pêcheurs de Grèce, et d'autres pays, se refusent encore à la mettre en application. Des recherches supplémentaires devront être faites concernant l'impact de cette recommandation. Le problème est le même que dans d'autres pays de la Méditerranée orientale; c'est-à-dire qu'il existe des pêcheries locales exploitant de petites espèces et que, pour certains pays (comme Chypre), la pêche est fortement tributaire de très petites espèces (Spicara smaris).

Israël[1/]

18. Le long des côtes d'Israël, la pêche est conduite au moyen de petits bateaux et la tendance actuelle semble favoriser les bateaux plus gros, équipés de moteurs plus puissants. Le nombre de bateaux présents dans ce secteur augmente régulièrement et il faudra peut-être envisager sous peu de prendre des mesures administratives pour en limiter le nombre.

19. Le nombre de navires opérant sur la pêcherie pélagique est en diminution, principalement en raison du bas prix des espèces pélagiques et de l'absence de demande.

20. Concernant la pêche au chalut, l'introduction de ce que l'on appelle les "mini-chalutiers", navires de 10-12 m de longueur utilisés pour pêcher la crevette dans des eaux profondes près du rivage, constitue un fait nouveau. Le nombre de chalutiers a augmenté de près de 60 % ces trois dernières années. Cette progression a été rendue possible par l'expansion de l'effort de pêche sur de nouveaux fonds repérés grâce à l'emploi généralisé d'instruments électroniques perfectionnés, ainsi que par la diversification et une meilleure conception des engins de pêche.

B. Maladies des éponges

21. La production grecque d'éponges a chuté depuis 1986, passant de 30-35 t environ à 10 t en 1987. D'après les résultats de premiers travaux de recherche, on pense que cela pourrait être dû à une mycose. Le délégué égyptien a signalé de son côté une diminution de la production égyptienne, passée de 8 à 4 t en 1987 pour une raison analogue. Le Secrétaire technique a mentionné qu'une maladie semblable avait récemment entraîné la fermeture de la pêcherie d'éponges en Tunisie et que le CGPM avait été approché par les services halieutiques Turcs demandant qu'une réunion extraordinaire soit organisée pour traiter de cette question. La délégation grecque a signalé que son pays étudie actuellement avec la Turquie des mesures communes pour résoudre ce problème. Comme les éponges situées à plus de 60 m de profondeur ne sont pas jusqu'ici touchées par la maladie, il se pourrait que d'autres facteurs qu'une simple infection fongique sont en cause.

C. Réglementation des pêches

Chypre

22. Le chalutage continue d'être interdit du 1er juin au 31 octobre et une profondeur minimum de 30 brasses est imposée pour les opérations de chalutage; d'autre part, une limite supérieure de 250 ch a été fixée pour les moteurs. Les inspecteurs des pêches vérifient que le maillage n'est pas inférieur à 34 mm en se servant du calibre CIEM (Conseil international pour l'exploration de la mer).

Egypte

23. Il s'est jusqu'ici révélé impossible de convaincre les pêcheurs d'adopter un maillage plus large. Très bientôt, un décret présidentiel interdira le chalutage du 15 juin au 15 septembre.

Grèce

24. Les réglementations actuellement en vigueur sont les suivantes:

(i) octroi de permis aux navires: l'entrée de la pêcherie est limitée (aucun accroissement du tonnage total n'est autorisé);

(ii) chalutiers: la pêche au chalut est fermée du 1er juin au 30 septembre; le maillage minimum (cul de chalut) est de 28 mm (maille étirée); la pêche est interdite à moins d'un mille ou, dans certains cas, à moins de 2 milles des côtes; de nombreux golfes et baies interdits au chalutage.

1/ Il n'y a pas eu de délégation d'Israël à la Consultation, mais un document intitulé "Situation de la pêche israélienne en Méditerranée" a été fourni. La Consultation est convenue que son propre rapport prendra en considération la contribution israélienne

(iii) senneurs de plage: il existe une période de fermeture qui va du 1er juin au 30 septembre:

- maillage minimum 16 mm (maille étirée),
- le senneur ne doit pas s'éloigner à plus de 70 m de la plage,
- de nombreux golfes et baies sont fermés
- la pêche de nuit n'est pas autorisée
- pas de nouvelles entrées.

(iv) senneurs (sennes coulissantes): il leur est interdit de pêcher à moins de 100 m de la côte et à moins de 30 m de profondeur: (a) pêche de nuit: maillage minimum 14 mm, (b) pêche de jour: maillage minimum 40 mm;

(v) espadon: la pêche à l'espadon est interdite du 1er octobre au 13 janvier;

(vi) aucun chalutage n'est autorisé à moins de 3 milles des estuaires;

(vii) taille des poissons: en règle générale, il est interdit de débarquer des poissons de taille inférieure de 8 à 16 cm, selon l'espèce.

25. Les limites de tailles appliquées dans les eaux grecques sont les suivantes:

Mullus barbatus Mullus surmuletus Pagellus erythrinus Boops boops Alosa falax nilotica	10 cm
Scomber scomber Scomber japonicus collias Teuchurus sp.	12 cm
Solea sp. Lichia amia Spaeus duratus	14 cm
Dicentra rehus sp. Mugil cephaleu	16 cm

26. Depuis quelques années, les permis délivrés aux amateurs et aux bateaux de pêche professionnels sont renouvelés tous les deux ans et un registre des navires est tenu à jour. Des restrictions ont été appliquées concernant les permis de pêche délivrés à des amateurs. Un décret présidentiel, dont la publication est imminente, définira le cadre juridique applicable à l'octroi de permis pour les navires et au droit de pêche.

Israël

27. Les réglementations concernant le maillage minimum et la taille des poissons sont actuellement les suivantes:

- cul de chalut, tous types	48 mm
- sennes coulissantes	20 mm

Taille minimum des poissons

Sardines, tous types	11 cm
Mullidés	11 cm
Boops boops	11 cm
Saurida undosquamis	12 cm
Pagellus erythrinus	12 cm
Toutes autres espèces commercialement importantes	20 cm.

28. Par suite du développement rapide de la pêche littorale et de la pêche au chalut ainsi que de l'apparition de ce que l'on appelle les "mini-chalutiers", il est devenu nécessaire de légiférer et d'introduire des mesures d'aménagement supplémentaires. C'est ainsi qu'a été instituée une zone exclusive où il est permis de caler des engins emmêlants, mais où le chalutage est interdit. D'autre part, une loi a été promulguée qui donne pouvoir à l'administration des pêches de limiter le nombre d'entrées de nouvelles embarcations de pêche sur les différents secteurs de pêche, d'imposer certaines restrictions concernant la taille et le type des engins de pêche et d'instituer des zones ou périodes de fermeture ou de limitation de la pêche. La plupart de ces réglementations ne sont pas encore entrées en vigueur et il faudra suivre de beaucoup plus près l'effort de pêche et les ressources ichthyques avant de pouvoir les rendre applicables.

V. ETAT DE LA RECHERCHE SUR LES RESSOURCES MARINES

Chypre

29. Le département des pêches du Ministère de l'agriculture et des ressources naturelles est responsable de ce type de recherche. Des données sont rassemblées sur les fréquences de longueur et la composition des captures, non seulement par des navires de recherche mais aussi par les chalutiers commerciaux qui sont en mer. L'objectif à atteindre est de parvenir à une meilleure connaissance de la dynamique des populations démersales.

Egypte

30. L'Institut d'océanographie et des pêches d'Alexandrie est le principal organisme de recherche s'occupant des pêches méditerranéennes; il travaille souvent en coopération avec la Faculté des sciences de l'Université d'Alexandrie, l'Institut national de la planification et la Faculté d'agriculture.

31. Précédemment, l'Egypte a mené des recherches sur les stocks méditerranéens avec l'URSS d'abord (1970-71), et plus récemment avec l'Italie (1983). Dans ce dernier cas, il s'agissait d'une prospection conduite à 600 m avec différents types de chaluts.

32. Des recherches sont également consacrées à l'aquaculture (par exemple sur la collecte d'alevins de muges pour le repeuplement des lagunes côtières): ces travaux sont décrits plus en détail à l'annexe R (contribution d'Ettewa). La mise en valeur des pêcheries lagunaires est une activité prioritaire; concernant la lagune de Bardowil, elle s'effectue avec une subvention de la CEE.

Grèce

33. Le Ministère de l'industrie, de l'énergie et de la technologie gère deux instituts de recherche halieutique: le Centre national pour la recherche marine à Athènes, l'Institut de biologie marine en Crête. Le Laboratoire des pêches du Pirée qui relève du Ministère de l'agriculture, s'occupe également de la recherche halieutique. En outre, diverses équipes des Départements de biologie de Thessalonique, d'Athènes, de Patras et de Crête s'occupent de recherches marines. Les chercheurs de ces différents instituts sont regroupés en unités fonctionnelles chargées de conduire des études déterminées.

34. D'une manière générale, le Centre national de la recherche marine s'occupe principalement d'étudier la dynamique des stocks démersaux de poissons commercialement importants, comme le merlu, le rouget barbet, le rouget de roche, le pageot commun et le poutassou. Un projet est actuellement en préparation qui consistera à étudier les ressources pélagiques au moyen de méthodes acoustiques. L'Institut de biologie marine de Crête s'occupe plus particulièrement, quant à lui, de l'évaluation des ressources des pêcheries pélagiques au moyen de méthodes hydro-acoustiques, ainsi que d'études sur la chaîne alimentaire. Les questions relatives à la dynamique des ressources essentiellement démersales sont également du ressort du Laboratoire des pêches. L'Institut de biologie marine de Crête (IBMC) est un cas particulier de collaboration entre l'Université et un institut de recherche. Organisme autonome, rattaché à l'Université de Crête, il a été créé en vue de promouvoir, dans les milieux universitaires, un effort coordonné dans le domaine de la recherche marine. La symbiose entre l'IBMC et l'Université de Crête s'est révélée mutuellement profitable. L'IBMC contribue au reclassement des études universitaires (niveau licence) et appuie un programme de maîtrise en recherche marine de l'Université de Crête. Cette solution résoud nombre de problèmes opérationnels car, grâce à son autonomie juridique, l'IBMC peut utiliser des procédures souples et non bureaucratiques. Inversement, l'Université de Crête fournit à l'IBMC du personnel scientifique ainsi que le cadre académique dans lequel s'inscrit le programme de maîtrise.

35. La recherche marine et halieutique dispose de deux navires de recherche. Le plus grand des deux (l'AEGAION, de 52 m de longueur) appartient au Centre national de la recherche marine, le plus petit (PHILIA, de 27 m de longueur) appartient à l'Institut de biologie marine de Crête. Ce sont tous deux des chalutiers dotés d'installations spéciales pour la recherche halieutique.

36. Outre le travail effectué par ces deux institutions sur des projets de recherche halieutique, les diverses équipes universitaires dont nous avons précédemment parlé étudient des questions présentant un intérêt particulier pour chaque Université. Par exemple, l'équipe de recheche halieutique de l'Université de Théssalonique travaille sur l'écologie et la systématique des Selachii égéens; sur la maturation gonadique et le cycle annuel de reproduction de la plupart des poissons commercialement importants; elle effectue des estimations des métaux lourds dans quelques poissons provenant de zones polluées, etc. L'Université d'Athènes a des projets concernant le plancton et le benthos; diverses études sur les oeufs de poissons et l'identification des larves, les taux de croissance et les aliments des principales larves de poissons, ainsi que l'évaluation des frayères figurent parmi les principales questions dont s'occupe l'équipe d'halieutistes de l'Université de Patras.

37. Ces dernières années, la recherche halieutique a bénéficié, en Grèce, d'un intérêt accru. Le développement de la recherche a été en partie soutenu au moyen de fonds fournis par la CEE et par des organisations internationales. Dans le cadre du projet pour la Méditerranée, il est prévu de créer deux nouveaux centres de recherche halieutique et de construire un nouveau navire de recherche.

38. La pêche thonière est connue en Grèce depuis l'âge classique, mais les thonidés n'ont jamais été un élément important de la pêche. Depuis que les Japonais sont acheteurs, les zones de pêche, géographiquement très limitées, sont en train de s'étendre. Des données sur l'effort de pêche et les captures sont actuellement rassemblées pour la pêcherie de thon rouge (Lefkaditou, Megalofonou, Tsimenides et De Metrio, annexe Q), pour d'autres thonidés et pour l'espadon.

Israël

39. En Israël, la recherche est actuellement axée sur: (i) le suivi de l'effort de pêche, (ii) l'étude des engins de chalutage et (iii) la pêche expérimentale à la palangre.

40. Le représentant de la CEE a rappelé qu'en 1987, la CEE a adopté des règles visant à coordiner les recherches halieutiques au sein de la CEE; elles sont assorties d'un programme d'une durée de cinq ans et d'un financement de 30 millions d'ECUs.

VI. COLLECTE DE STATISTIQUES DES PECHES

A. Types de données collectées

Chypre

41. Des données sur les captures et l'effort de pêche sont rassemblées régulièrement par la flottille de chalutiers pour les espèces démersales; les données concernant les captures commerciales sont rassemblées par des fonctionnaires de district dans les principales villes; en outre, tous les patrons de chalutiers tiennent des livres de bord. Des données sur la pêche littorale sont rassemblées chaque mois, et des statistiques totales sont établies par estimations - rapportées au poids de l'ensemble de la capture.

42. L'échantillonnage biologique des chalutiers se fait en mer, les petits bateaux sont échantillonnés au port. Les captures des chalutiers sont échantillonnées en vue d'établir la fréquence de taille par espèce, ainsi que les stades de maturité.

Egypte

43. L'Institut d'océanographie et des pêches d'Alexandrie a des programmes d'échantillonnage des captures dans les principaux ports.

Grèce

44. Après la deuxième guerre mondiale, la flottille grecque de senneurs a dû être en grande partie reconstruite; en 1948, elle comptait déjà 220 navires. L'expansion de la flottille s'est ralentie vers les fins des années 70, pour atteindre 376 navires en 1986. Mais la puissance moyenne de la flottille a continué de croître, passant de 49 ch en 1948 à 207 ch en 1986 (voir annexe N, contribution de Tsimenides). La flottille de chalutiers a connu une évolution similaire.

45. Divers services participent au rassemblement des données sur les pêches en Grèce; il s'agit principalement de l'Office national de statistique, du Département des pêches et de la Banque agricole de Grèce, chacun ayant des priorités quelque peu différentes concernant le type de données rassemblées.

46. Les données concernant la dimension de la flottille composée des navires de plus de 20 ch sont répertoriées et utilisées dans le cadre de la limitation des permis de pêche. Des données concernant les captures et les prix par secteur sont également rassemblées périodiquement et transmises par les centres régionaux et les autorités portuaires à l'Office national de statistique.

Israël

47. Des données sur les pêcheries littorale et pélagique sont rassemblées dans les principaux ports (voir le rapport national par Grofit, à l'annexe T); des problèmes de personnel influent sur la fiabilité de ces données. Les données concernant l'effort sont relativement bien représentées grâce à un système de communications radio utilisé chaque jour par les navires, encore que les types d'engins/navires ne soient pas parfaitement définis. Un bulletin statistique général est publié en anglais et en hébreu.

B. **Progrès accomplis concernant la constitution, l'informatisation et la diffusion de bases de données halieutiques**

48. A Chypre, en Egypte, en Grèce et en Israël, les données statistiques sont maintenant stockées sur ordinateur. En Egypte, l'organisation chargée de la mise en valeur des ressources halieutiques a installé dans ce but, en 1987, deux micro-ordinateurs compatibles avec IBM. Les données compilées concernent les navires, la puissance ch, le type d'engin et la capture (pas par espèces). A partir de 1988, le personnel sera formé à la ventilation des captures par principales espèces et tailles.

49. En Grèce, un organisme public semi-autonome, la Société Etanal, est chargé de stocker les données relatives aux pêches; il a mis au point un programme quadriennal de Traitement électrique des données (TED) en vue de gérer les données sur les captures. Le programme a été jusqu'ici centré sur le principal port du Pirée, qui reçoit quelque 50 % des captures des sept ports de débarquement officiels. Les chiffres des captures sont compilées chaque jour (quantités et valeur) et un bulletin statistique paraît chaque mois. Il est prévu d'étendre cette base de données aux autres ports de pêche officiels et de relier Etanal aux centres régionaux.

50. Le rassemblement de données primaires correctes et le codage de ces données par espèces/noms sont des opérations indispensables; une opération de codage des espèces est actuellement en cours. Le Secrétaire technique a suggéré de contacter M. W. Fischer, à la FAO, qui s'occupe actuellement de mettre au point, sur la base des nouvelles fiches d'identification des poissons méditerranéens, une base de données normalisées du même genre. La délégation grecque a fait bon accueil à cette suggestion.

51. Le délégué égyptien a rappelé la nécessité de former des fonctionnaires nationaux aux méthodes de collecte des données et a suggéré qu'il serait extrêmement souhaitable d'organiser un cours de formation spécialisé à l'intention du personnel des pêches de la Méditerranée orientale. La délégation grecque a appuyé cette suggestion.

Effort de pêche

52. Concernant les systèmes nationaux de communication des données, tous les pays publient des bulletins annuels des captures mais ils n'ont pas encore commencé à utiliser les unités d'effort normalisées recommandées au paragraphe 55 du rapport de la dernière Consultation.

53. La délégation grecque a fait savoir que la normalisation des données concernant l'effort de pêche, pose certains problèmes, mais que l'on s'emploie actuellement à rassembler ce type d'informations dans chaque port pour les petits pélagiques et que certains travaux ont déjà commencé sur les grands pélagiques. Dans ce domaine, l'Université de Crète a entrepris de constituer une base de données sur l'effort de pêche, notamment pour la sardine et l'anchois. Le gouvernement concentre la majeure partie de ses efforts dans ce secteur sur la pêche au chalut et à la senne de plage.

54. Le Secrétaire technique a rappelé que, avant d'estimer l'effort total de pêche en unités normalisées, il faut suivre l'évolution des taux de capture par type de navire, et utiliser le taux de capture pour calibrer la classe d'appartenance de navires par rapport à la norme.

VII. PROGRAMMES DE TERRAIN ET PROSPECTIONS, NOTAMMENT ETAT DES ETUDES ACOUSTIQUES, DES PROSPECTIONS DES RESSOURCES DEMERSALES ET DES PROSPECTIONS PRERECRUTEMENT

(a) Etudes acoustiques

55. Chypre n'a pas exécuté récemment d'études acoustiques; quant à l'Egypte, son expérience se limite au programme de coopération égypto-italien mentionné plus haut.

56. En Grèce, un programme d'études acoustiques, soutenu financièrement par le Ministère de l'agriculture, a démarré en 1975 et a finalement été exécuté en 1984 par l'Institut de biologie marine de Crète. Ses principaux objectifs sont les suivants:

- estimer l'abondance des stocks de petits pélagiques et en définir la migration verticale;
- établir quels sont les facteurs d'environnement qui influent sur la répartition des stocks.

57. Deux navires, tous deux équipés de sonars, sont actuellement disponibles:

- le navire de recherche PHILIA, de 27 m, appartenant à l'Institut de biologie marine de Crète, équipé d'unités 2 EK 400 Simrad 120 + 38 KH avec écran couleurs, et
- le navire de recherche AEGAION (52 m) appartenant au Centre national de recherche marine, équipé d'un sonar et d'instruments similaires, qui entrera en service sous peu.

58. Le PHILIA a déjà accompli une série de prospections dans le nord de la mer Egée: cette année, il sera dans le milieu de la mer Egée et reprendra certaines des stations de l'année dernière.

59. Des données sur l'abondance des poissons pélagiques sont rassemblées jusqu'à 10 strates de profondeur et stockées sur ordinateur pour analyse et cartographie.

60. Outre les données du sonar, on effectue des échantillonnages avec un chalut semi-pélagique et le résultat est comparé avec les captures commerciales. Des profils de la température, de la salinité et de la teneur en oxygène sont établis sur chaque station.

61. Il faut vérifier la situation réelle en ce qui concerne ce que l'on appelle le cycle de prédominance sardine-anchois, et il en sera tenu compte dans le cadre d'une part des études à long terme exécutées avec les sonars, mais aussi d'un contrat passé par la CEE avec l'Université de Crète et l'Union panhellénique des coopératives agricoles, ainsi qu'avec l'Impérial College de Londres, pour analyser les données grecques. La Consultation a suggéré que l'on tienne le CGPM informé des résultats de cette étude.

(b) Prospections par chalutages, notamment prospections des juvéniles

62. Le Département des pêches de Chypre a entrepris, avec un navire de recherche, des prospections par chalutages destinées principalement à localiser les zones de frayères et les époques de reproduction des espèces démersales. Cette année, un programme d'identification des stocks a également démarré. Il durera trois ans et facilitera l'établissement de mesures d'aménagement. Il est prévu aussi d'exécuter, en utilisant une petite maille (8 mm) de cul de chalut, une prospection pré-recrutement en octobre, juste avant l'ouverture (en novembre) de la campagne de chalutage, pour estimer la dimension du stock.

63. Le Centre national grec de la recherche marine effectue chaque année des prospections portant sur des zones et des ressources particulières, par exemple sur les merlus, muges, Nephrops et pageots rouges. Les enquêtes par chalutages effectuées dans diverses zones tiennent compte des priorités nationales fixées pour l'aménagement des pêches. Pendant les prospections, des prélèvements sont effectués selon une grille de stations préétablie et répétés à chaque campagne sur toute la durée du projet. Toutefois, il ne semble pas que les prospections suivent un itinéraire de croisière fixe, non plus qu'un plan d'échantillonnage aléatoire repris chaque année sur l'ensemble de la zone. Les chalutiers commerciaux sont également utilisés à des fins de prospections. A ce jour, les zones correspondant aux golfes de Saronikos, Patraikos, Korinthiakos, Eubiokos, Pagassitikos et Thermaikos, ainsi que les mers Ionienne et de Thrace ont été ainsi étudiées. Plus récemment, de nouveaux programmes de prospections ont inclus une étude comparative des zones pêchées et non pêchées et de premiers travaux ont été faits en vue d'étudier les oeufs et les larves. Concernant l'alimentation et les aliments des poissons marins, la Grèce fournit déjà et depuis beaucoup plus longtemps un effort de recherche considérable.

(c) Conception des prospections scientifiques

64. Il est évident que ce sont les nécessités de l'aménagement des pêches qui, dans une certaine mesure, dictent les objectifs des prospections et leur conception. Comme il est dit dans le document présenté par le Secrétaire technique, si l'objectif visé est celui d'un aménagement par contingentement, il faudra absolument effectuer des prospections de la biomasse couvrant toute l'aire de distribution du stock et utiliser un système d'échantillonnage complet et en temps réel. Si par contre les prospections scientifiques ont pour principal objectif d'obtenir une série chronologique des tendances de l'abondance (cpue), notamment pour les juvéniles, il suffira d'un échantillonnage indicatif des fonds les plus productifs et des nurseries côtières effectué annuellement (éventuellement complété par une estimation de la biomasse totale faite à intervalles de plusieurs années sans perdre la continuité de l'échantillonnage).

65. En supposant qu'on n'envisage pas un aménagement par contingents, on pourra utiliser ce type de série annuelle d'estimations des tendances du recrutement pour les principales espèces dans le cadre d'une évaluation Thompson-Bell des rendements pour prédire les tendances de la pêcherie dans l'année à venir et pour établir les effets éventuels des campagnes de pêche et de la stratégie de pêche de l'impact d'autres interventions humaines (comme la pollution côtière) sur la ressource.

(d) Grands pélagiques

66. Soixante-quinze flottilles pêchent l'espadon dans les eaux grecques, avec un total de 334 bateaux; De Metrio, Megalofonou et Tsimenides (annexe O) ont rendu compte d'une étude préliminaire de cette activité. La reproduction semble avoir lieu principalement en juillet et en août et les captures des diverses flottilles font apparaître une grande diversité en ce qui concerne la distribution des tailles. La dynamique de cette population est encore à établir mais son exploitation nécessite de toute évidence une politique commune à la dimension de la région.

VIII. OCEANOGRAPHIE HALIEUTIQUE, SURVEILLANCE DE L'ENVIRONNEMENT ET COLLECTE DE DONNEES UTILES POUR LES PECHES

67. Un grand programme océanographique coopératif est actuellement en cours d'exécution dans la Méditerranée orientale; il associe huit pays et plusieurs instituts appartenant ou non à la région. L'océanographie physique de la Médirerranée orientale présente un certain nombre de caractéristiques intéressantes pour la pêche et soulève quelques questions.

68. D'avril à octobre et durant tout l'été, il existe le long de la limite orientale de la mer Egée une remontée (upwelling) persistante, mais qui n'est pas associée à un apport important de production primaire aux réseaux alimentaires. Selon toute probabilité, cela semble indiquer que les eaux du fond sont également pauvres en élément nutritifs, ce qui confirmerait le caractère essentiellement oligotrophe de la zone si on la compare, par exemple, à la mer Adriatique. Les teneurs en éléments nutritifs sont en général entre le cinquième et le vingtième de ce qu'elles sont dans d'autres parties de la Méditerranée, par exemple en mer Ionienne (pour plus de détail, voir Friligos, annexe V).

69. Deux autres aspects intéressants ont été signalés à ce propos: les eaux du fond de la mer Egée sont pour une grande part séparées du reste des eaux profondes de la Méditerranée et d'autre part, elles reçoivent des eaux de surface provenant des Dardanelles. Enfin, un certain degré d'eutrophisation est visible dans les zones, baies et golfes proches des côtes (voir Friligos, annexes V et Y).

70. Il faut espérer que de nouveaux renseignements, concernant par exemple les systèmes cycloniques et anticycloniques de cette zone, contribueront à l'étude de la structure des stocks de petits pélagiques ainsi que d'espadons, dont la répartition est généralement associée aux fronts maritimes.

IX. PROGRES ACCOMPLIS CONCERNANT LES APPLICATIONS DE L'EVALUATION DES STOCKS A L'AMENAGEMENT DES RESSOURCES

71. Un certain nombre de nouvelles évaluations dont beaucoup ne sont que provisoires, des ressources ichthyques ont été présentées à la Consultation, en particulier pour:

- Spicara smaris (par Tsangridis et Filippoussis, annexe K),
- Mullus barbatus (par Karlou et Vrantzas, annexe D, ainsi que par Livadas, annexe E),
- Pagrus pagrus (par Vassilopoulou, annexe L),
- Pagellus erythrinus (par Mytilineou, annexe H),
- Boops boops (par Livadas, annexe F),
- Micromesistius poutassou (par Papaconstantinou et Petrakis, annexe I)

72. Ces évaluations préliminaires ont donné lieu à un débat qui a surtout porté sur l'effet probable de variations des paramètres sur les évaluations elles-mêmes. Un problème courant (que connaissent aussi des chercheurs travaillant en d'autres points de la Méditerranée) vient de ce que l'on ne connaît par très bien les valeurs du facteur de croissance K de Von Bertalanffy qui est directement utilisé soit pour calculer le rendement par recrue selon la formule de Beverton et Holt, soit pour estimer M, la sélectivité et Z (d'après les courbes des captures converties en longueurs) par les méthodes de Pauly et Wetherall. Le principal problème en ce qui concerne les estimations de la croissance semble être celui qui est évoqué au paragraphe 56 du rapport de la première Consultation, à savoir les faibles valeurs prédites pour K et les très faibles valeurs négatives de t.

73. Il semble que cela tienne en partie aux méthodes utilisées actuellement pour ajuster la courbe de croissance, mais plus encore au manque de données concernant la taille des poissons pendant la première année de vie.

74. Comme l'avait noté la première Consultation au paragraphe 61 de son rapport, il est très important de définir correctement le taux de croissance au cours des deux premières années de vie. La taille moyenne en fonction de l'âge (durant ces premières années) est une donnée qui devrait probablement être suivie de trois mois en trois mois.

75. En utilisant les données taille/âge pour les six premiers mois de vie, on obtiendra certainement une courbe de croissance passant à proximité de l'origine. Si l'on ne dispose pas de telles données, il serait quand même instructif de voir quelles sont les valeurs de K et que l'on obtiendrait si l'on fait passer la courbe de croissance à proximité de l'origine. Ces valeurs devraient être pour le moins indicatives de l'écart possible des valeurs de K et pourraient fournir une série vraisemblable de paramètres conduisant à une fourchette d'estimations de l'état d'exploitation du stock plus ou moins susceptible d'inclure la situation réelle. Des observations complémentaires découlant d'analyses ultérieures figurent en annexes M, W et X par Caddy).

76. Dans son document, le Secrétaire technique a réservé une haute priorité à la nécessité d'une part de combler les lacunes des données et d'autre part, de résoudre les problèmes importants que

pose la première année de vie, notamment dans le cas des espèces démersales. La plupart des espèces démersales accomplissent près du tiers de leur croissance dans les zones de nurseries, probablement dans les eaux peu profondes proches de la côte. Il semble qu'il n'y ait pour ainsi dire pas de données concernant les espèces démersales dans les captures commerciales de poissons de 100 mm de longueur, ce qui incidemment laisse à penser que la stratégie gouvernementale qui a consisté à interdire le chalutage dans ces zones contribue, de façon au moins aussi efficace que ne le ferait l'augmentation du maillage, à réduire les captures de poisson de petite taille.

77. La stratégie qui pourrait être utilisée pour étudier une réglementation du maillage a été discutée et il a été conclu que:

- Avant de réglementer le maillage sur l'ensemble d'une pêcherie, il conviendrait de vérifier expérimentalement les effets d'une telle mesure dans une zone de superficie limitée afin de pouvoir convaincre les pêcheurs de ses incidences probables.

- Etant donné que la croissance est très rapide pendant la première partie du cycle biologique, durant laquelle l'emploi d'une maille de (disons) 28 mm, détermine une rétention partielle, les pertes de rendement à court terme seraient de courte durée, et certainement inférieure à un an.

- La meilleure stratégie consiterait à introduire un nouveau maillage après une période de fermeture destinée à permettre aux poissons juvéniles d'atteindre la taille voulue pour être retenus par la nouvelle maille.

- Une bonne connaissance des taux de recrutement et de croissance des juvéniles est, à l'évidence, un préalable indispensable.

- Il est nécessaire de contrôler les niveaux d'effort en même temps que les accroissements du maillage, si l'on veut éviter que la surpêche ne réduise cette mesure à néant.

X. RECOMMANDATIONS EN MATIERE DE RECHERCHE ET D'AMENAGEMENT ET PROGRAMMES COOPERATIFS EVENTUELS

Recherche

78. La Consultation est convenue qu'il faudrait étudier en priorité la première année du cycle biologique des poissons démersaux, afin d'améliorer les estimations des débuts de la croissance et d'élaborer des indices du recrutement.

79. Etant donné le caractère particulier des cycles biologiques et des habitats des poissons démersaux de la Méditerranée, on a estimé qu'il faut généralement être prudent quand on emploie des méthodes d'estimation des paramètres reposant uniquement sur des corrélations statistiques par rapport à d'autres zones (par exemple, formule de Pauly pour M). Il vaudrait mieux essayer d'évaluer M directement, par exemple d'après des estimations séquentielles de l'abondance des juvéniles dans les zones côtières et d'après des études conduites dans des zones fermées à la pêche (analyse des courbes des captures pour la composition par âges).

Grands pélagiques

80. Notant avec préoccupation que l'on ne possède pas de données suffisamment complètes concernant la situation des grands pélagiques dans toute la zone méditerranéenne et consciente de ce que seulement trois pays riverains de la Méditerranée sont membres de la CICTA, la Consultation a estimé que le CGPM devrait prendre des dispositions en vue d'évaluer l'état de ces stocks. Elle s'est félicitée de l'offre faite par la délégation grecque d'appuyer l'organisation d'une consultation technique portant sur cette question, et a demandé au Secrétariat de veiller à ce que la CICTA et ceux de ses pays membres qui participent à la pêche thonnière en Méditerranée y soient étroitement associés.

Formation de statisticiens des pêches à l'échantillonnage biologique

81. La Consultation a insisté sur la nécessité d'organiser en Méditerranée orientale un stage de formation qui aurait pour but de préparer des fonctionnaires nationaux aux:

- critères statistiques de conception des échantillonnages biologiques,

- méthodes d'échantillonnage dans les ports,

- méthodes de traitement électronique des données pour le stockage et le tri des données sur micro-ordinateur.

82. Le stage devrait avoir lieu dans un port de pêche de la Méditerranée où l'échantillonnage se pratique couramment, afin de pouvoir expérimenter différents protocoles pratiques.

Maladie des éponges

83. Vu la très alarmante propagation de la maladie qui touche les éponges méditerranéennes, la Consultation est convenue qu'un programme de recherche coopératif devrait être lancé dans les plus brefs délais. Ce programme devrait associer non seulement les pays de la Méditerranée orientale, mais aussi ceux dont les eaux abritent la maladie. Dans un premier temps, le Secrétariat devra se mettre en contact avec les pays membres et commencer à rassembler et diffuser les informations disponibles concernant ce phénomène. Entretemps, les pays membres verront s'ils peuvent faire appel au Programme de coopération technique de la FAO. S'il existe une telle possibilité, il faudra recruter un consultant qui sera chargé d'établir un programme de recherche détaillé, de coordonner les activités des instituts de recherche nationaux participant à l'exécution du programme, et d'organiser une réunion qui devra s'attaquer au problème. Il a été suggéré d'inscrire cette question à l'ordre du jour de la prochaine session du CGPM.

Maillage

84. L'attention de la Consultation a été appelée sur une recommandation formulée par la cinquième Consultation technique sur l'évaluation des stocks dans les divisions techniques des Baléares et du golfe du Lion et visant à faire adopter par le CGPM une recommandation potentiellement contraignante relative au maillage des chaluts. La Consultation a reconnu qu'une augmentation de la dimension des mailles actuellement utilisées ne pourrait être que bénéfique pour les pêches de la Méditerranée orientale à condition qu'elle soit complétée, au niveau national, par d'autres mesures réglementaires appropriées telles que l'institution d'une période de fermeture, d'une zone de fermeture et/ou mesure de réduction de l'effort de pêche. Il a été souligné cependant que, en raison de la forte résistance des pêcheurs à toute modification du maillage actuellement utilisé, plusieurs pays de la sous-région auraient de très grosses difficultés à mettre en application une recommandation contraignante.

XI. AUTRES QUESTIONS

85. Aucune autre question n'a été soulevée.

XII. DATE ET LIEU DE LA PROCHAINE CONSULTATION

86. La Consultation est convenue que le Conseil déciderait, à sa quatre-vingt-dixième Session, de la date et du lieu de la troisième Consultation.

XIII. ADOPTION DU RAPPORT

87. Le présent rapport a été adopté le 1er avril 1988.

APPENDIX A

Agenda

1. Opening of the Consultation

2. Adoption of the Agenda

3. Election of the Chairman and Vice-Chairman

4. Status of national fisheries, new developments in the fisheries sector, and new fisheries regulations introduced in:

   (a) The small pelagic fisheries
   (b) The large pelagic fisheries
   (c) The demersal fisheries
   (d) The invertebrate fisheries

5. Status of marine resources research

   (a) Institutes involved and main elements of their fisheries research programmes
   (b) National priorities in marine research and main problems encountered

6. Status of statistical collection in the fisheries sector

   (a) Types of data being collected by resource and vessel/gear category

      (i) Catch and effort
      (ii) Sampling for sizes and ages
      (iii) Other biological sampling

   (b) Progress achieved in construction of fisheries data bases and computerization

   (c) National reporting of fisheries statistics in the Eastern area of the General Fisheries Council for the Mediterranean

7. Matters arising from the First Consultation

   (a) Progress report on research on the key species selected by the First Consultation
   (b) New estimates of population parameters for key resources
   (c) Initiative in mapping the distribution of resources and fleets

8. Field programmes and surveys, including status of acoustic, demersal and pre-recruit surveys

   (a) Acoustic surveys
   (b) Trawl surveys
   (c) Juvenile fish surveys

9. Status of fisheries oceanography and environmental monitoring and data collection of relevance to fisheries

10. Progress in the application of stock assessment to resource management

11. Recommendations in matters of research and management, and on possible cooperative programmes

12. Any other matters

13. Date and place of the next Consultation

14. Adoption of the Report

ANNEXE A

Ordre du jour

1. Ouverture de la Consultation

2. Adoption de l'ordre du jour

3. Election du Président et du Vice-Président

4. Etat des pêches nationales, faits récents survenus dans le secteur halieutique et nouvelles réglementations en la matière adoptées pour:

   (a) les pêcheries de petits pélagiques
   (b) les pêcheries de grands pélagiques
   (c) les pêcheries démersales
   (d) les pêcheries d'invertébrés

5. Situation de la recherche en matière de ressources marines

   (a) Instituts intéressés et principaux éléments de leurs programmes de recherche halieutique
   (b) Priorités nationales de la recherche marine et principaux problèmes rencontrés

6. Situation de la collecte de statistiques dans le secteur des pêches

   (a) Types de données actuellement rassemblées par catégorie de ressources et de navires/engins de pêche

      (i) Capture et effort
      (ii) Echantillonnage pour déterminer les tailles et les âges
      (iii) Autres échantillonnages biologiques

   (b) Progrès réalisés en matière de constitution et informatisation des bases de données sur les pêches

   (c) Communication nationale des statistiques des pêches dans la partie orientale de la zone couverte par le Conseil général des pêches pour la Méditerranée

7. Questions découlant de la première Consultation

   (a) Rapport d'activités sur la recherche sur les espèces clés retenues par la première Consultation

   (b) Nouvelles estimations des paramètres de population pour les ressources clés

   (c) Travaux cartographiques concernant la répartition des ressources et des flottilles

8. Programmes de terrain et prospections, notamment état des prospections acoustiques, démersales et pré-recrutement

   (a) Prospections acoustiques

   (b) Prospections par chalutage

   (c) Prospections des juvéniles

9. Situation de l'océanographie halieutique, de la surveillance du milieu et de la collecte de données intéressant la pêche

10. Progrès concernant l'application de l'évaluation des stocks à l'aménagement des ressources

11. Recommandations en matière de recherche et d'aménagement, et d'éventuels programmes de coopération

12. Questions diverses

13. Date et lieu de la prochaine Consultation

14. Adoption du Rapport

APPENDIX/ANNEXE B

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APPENDIX/ANNEXE C

List of Documents/Liste des documents

A. DEMERSAL RESOURCES/RESSOURCES DEMERSALES

1. Evaluation of the Relative Yield per Recruit Approach in the Case of the Stock of Red Mullet (Mullus barbatus L. 1758) in the Saronikos Gulf (by C. Karlou and N. Vrantzas)

2. A Study of the Growth and Maturity of Striped Mullet (Mullus barbatus L), in Waters of Cyprus (by R.J. Livadas)

3. The Growth and Maturity of Bogue (Boops boops L), Family Sparidae, in Waters of Cyprus (by R.J. Livadas)

4. A Study of the Biology and Population Dynamics of Pandora (Pagellus erythrinus L, 1758), Family Sparidae, in the Seas of Cyprus (by R.J. Livadas)

5. Données biologiques sur le pageot, Pagellus erythrinus, des côtes orientales de la Grèce centrale (par C. Mytilinéou)

6. Some Data on the Population Dynamics of Blue Whiting (Micromesistius poutassou) in the Northern Euvoikos Gulf (by C. Papaconstantinou and G. Petrakis)

7. Feeding of Poor-Cod (Trisopterus minutus capelanus R.) in the Euboean and Pagassitikos Gulfs (Greece) (by C.-Y Politou, K. Stergiou and G. Petrakis)

8. Length-based Approach to the Estimation of Growth and Mortality Parameters of Spicara smaris (L.) in the Saronikos Gulf, Greece, and Remarks on the Application of the Beverton and Holt Relative Yield per Recruit Model (by A. Tsangridis and N. Filippoussis)

9. Some Biological Parameters on the Red Porgy (Pagrus pagrus) in the Kastellorizo Area (by V. Vassilopoulou)

10. A Research Strategy in Support of Stock Evaluation of Demersals in the Mediterranean Sea (by J.F. Caddy)

B. PELAGIC RESOURCES/RESSOURCES PELAGIQUES

11. The Acoustic Survey Programme in Greek Waters (by N. Tsimenides)

12. Fishery and Biology of the Swordfish Xiphias gladius, L., 1758, in Greek Waters (by G. De Metrio, P. Megalofonou, S. Tselas and N. Tsimenides)

13. Fisheries for Large Scombrids in Greek Waters: Catches of Thunnus alalunga (Bonn 1788) (by G. De Metrio, P. Megalofonou, S. Tselas and N. Tsimenides)

14. Fisheries for Large Scombrids in Greek Waters: Catches of Bluefin Tuna (Thunnus thynnus L.) (by E. Lefkaditou, P. Megalofonou, G. Demetrio and N. Tsimenides)

C. GENERAL

15. Report on the Egyptian Fisheries Focusing on the Mediterranean (by I. Ettewa)

16. The Present Situation and Current Trends in Development of Fishing Activities in Greece (by M. Kotsolios)

17. An Updated Report on the State of Israeli Mediterranean Fisheries (by E. Grofit)

18. The Selectivity of Certain Trawl Cod-Ends in Cyprus (by R.J. Livadas)

19. Nutrient Status in the Aegean Waters (by N. Friligos)

20. A Note for Fishery Workers in the Eastern Mediterranean on the Estimation of Values for M (by J.F. Caddy)

21. Comments on Yield Calculation Presented at Recent GFCM Technical Consultations on Stock Assessment (by J.F. Caddy)

APPENDIX/ANNEXE D

Evaluation of the Relative Yield per Recruit Approach in the Case of the Stock of Red Mullet (Mullus barbatus L. 1758) in the Saronikos Gulf

by

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1. INTRODUCTION

Red mullet is a common species in Greek waters with a high commercial value. Aspects of the biology and population dynamics of this species in Greece have been studied previously using age data (Papaconstantinou, Tsimenidis and Daoulas, 1981; Papaconstantinou, Caragitsou and Panos, 1986). In the present study growth parameters and mortality rates of red mullet in the Saronikos Gulf have been estimated using length frenquency data. The relative yield per recruit model of Beverton and Holt (1964) was used to explore the effect of a reasonable range of input parameters on the yield per recruit from this red mullet stock.

2. MATERIALS AND METHODS

Samples of red mullet from the Saronikos Gulf (Figure 1) have been collected in trawl surveys carried out monthly during the spring and autumn of the years 1985 and 1986. A chartered commercial trawler of 420 hp was used. The mesh size in the cod-end of the trawl was 14 mm between stretched knots. Trawl hauls lasted about one hour. Stratified samples taken according to Gulland (1966) were used to determine the frequency distribution of total length and that of maturity stages (scale of Nikolsky, 1976) in the catch for each sex and sampling month.

Growth curves were drawn on plots of all monthly length frequency data repeated twice following the "integrated" method described by Pauly (1983). Estimates of the growth parameters L_{oo} and K for each sex and for the mixed population were derived from these curves using the Ford-Walford plot. A second value of L_{oo} for the mixed population and a ratio of Z (total mortality coefficient) over K were computed according to Wetherall, Polovina and Ralston (1987) from equations:

$$L_{oo} = \frac{a}{1-b}$$ where, a, b are the intercept and slope of the linear segment of the function $\bar{L}_i = f(L_i)$ in which $\bar{L}_i$ is average length of fish belonging to length classes from L_i upwards.

$$Z/K = \frac{b}{1-b}$$

The value of Z/K was split into Z and K following the method of Pauly and Munro (Pauly and Munro 1984; Pauly 1986). In this method from the equation: $\bar{Q} = \log K_i + \log L_{ooi}$, where K_i and L_{ooi} are growth parameters for various red mullet stocks reported in the literature, the quantity $\bar{Q}$ was computed. Then the value of L_{oo} estimated by the Wetherall, Polovina and Ralston, method was used in the above equation to derive a second "independent" value of K.

Values of Z were determined for the mixed population for each year from the descending parts of length-converted catch curves (Pauly, 1983a). Values of Z for each year were also computed using the equation of Beverton and Holt (1956):

$$Z = \frac{K(L_{oo} - \bar{L})}{\bar{L} - L'}$$ where: $\bar{L}$ is the mean length of all fish $\geqslant L'$
L' is the smallest length of fish that are fully represented in the catches (cf. Pauly, 1983, 1984a)

An additional single value of Z was derived by multiplication of the value of Z/K obtained from the method of Wetherall, Polovina and Ralston, by the estimate of K obtained after Pauly and Munro.

The value of M (natural mortality coefficient) was determined using the empirical equation of Pauly (1980):

$\log M = - 0.0066 - 0.279 \log L_{oo} + 0.6543 \log K + 0.4634 \log T$
where: L_{oo} (total length: cm) and K are the Von Bertalanffy parameters, and T is the mean annual water temperature.

An estimate of the current exploitation rate (Ecurr.) of the stock was obtained from the ratio of fishing mortality (F) to total mortality (Z=F+M). A range of this estimate was computed according to Gulland (1984) following his suggestions about the likely ranges of M and Z.

Values of the average lengths at first capture (L'_c) were derived from the ascending parts of the length-converted catch curves (Pauly, 1984).

Finally, the Beverton and Holt (1964) relative yield per recruit model was followed to explore the effect of fishing on the red mullet stock for a range of growth and natural mortality parameters. In assessing the relative position of $E_{curr.}$ the concept of $E_{0.1}$ ("best" exploitation rate) suggested by Pauly (Pauly, 1986), being analogous to the $F_{0.1}$ (Gulland and Boerema, 1973, Gulland, 1984a), was used instead of the E_{max} criterion (exploitation rate corresponding to maximum yield).

3. RESULTS

A. Growth

An example of a growth curve constructed according to the "integrated" method is shown in Figure 2. The estimates of L_{oo} and K values were:

Males	Females	Males and Females
L_{oo} = 215.03 mm	L_{oo} = 286.63 mm	L_{oo} = 248.99 mm
K^{oo} = 0.2713	K^{oo} = 0.1515	K^{oo} = 0.1716

The values of L_{oo} and Z/K derived by the use of the Wetherall *et al.*, method (Table 1, Figure 3) were:

$\bar{L}_{oo}$ = 247.85 mm Z/K = 6.048 and the relevant regression coefficient r = 0.996. The value of K computed by the procedure of Pauly and Munro (Table 2) was: K = 0.1678.

The mean of the L_{oo} values and that of the corresponding K values determined by the different methods employed for the mixed population were:

$\bar{L}_{oo}$ = 248.42 mm $\bar{K}$ = 0.1697

B. Mortality

The values of Z estimated by the use of length-converted catch curves were:

Z_1 = 0.949 (catch data of 1985, Table 3, Figure 4)
Z_2 = 0.930 (catch data of 1986, Table 4, Figure 5) giving
$\bar{Z}_{1,2}$ = 0.940 as a mean value.

The values of Z from the application of Beverton and Holt equation were:

Z'_1 = 0.864 (year 1985)
Z'_2 = 0.840 (year 1986) giving

$\bar{Z}'_{1,2}$ = 0.852 as a mean value

The coefficient Z estimated by the combination of the Wetherall *et al.*, and Pauly and Munro methods was:

Z" = 1.015

The grand mean of these values of Z was: $\bar{Z}$ = 0.936

Natural mortality (M) computed from the equation of Pauly was:
M = 0.455. In this equation the values of $\bar{L}_{oo}$ and $\bar{K}$ were used and T was taken as 16°C, which is the mean annual water temperature at 100 m depth, where the fish were found to be most abundant (unpublished observation).

C. Exploitation rate

$E = \frac{F}{Z}$

The exploitation rate estimated by the use of the M and $\bar{Z}$ values was: $E_{current} = 0.514$ with a range 0.220 - 0.680.

D. Selectivity

The average length at first capture (L'_c) was estimated for each year separately as:

$L'_{c1} = 133.09$ mm (1985, Table 5, Figure 6)
$L'_{c2} = 123.81$ mm (1986, Table 6, Figure 7) giving

$\bar{L}'_c = 128.45$ mm as a mean value (Table 7).
The value of the parameter c used in the relative yield per recruit model was 0.52 (Table 7).

E. Relative yield per recruit (Y/R)

Given some uncertainties as to the early growth of Mullus barbatus due to the high value of length at first capture, a broader range of K values was used in combination with a range of M values to explore the effects of fishing on the yield curve. Four sets of calculations were carried out for the combinations of K and M values shown below:

K	M	Z	M/K	F	c	$E_{curr.}$	$E_{0.1}$
0.1	0.2	0.495	2.00	0.295	0.52	0.596	0.80
0.4	0.2	1.975	0.50	1.775	"	0.899	0.65
0.1	0.5	0.495	5.00	not possible			
0.4	0.5	1.975	1.25	1.475	0.52	0.747	0.70

One example of relative yield per recruit curves are those given in Figures 8 and 9 for the combination of K and M values found in the present study.

4. DISCUSSION

Various, apparently independent, methods of analysis of length frequency data were employed in the present study for the estimation of each of the growth and mortality parameters L_∞, K and Z in an attempt to increase the confidence in the estimates. Interestingly the estimates of each parameter by different methods were found to be close. It is also worth noting that the values L_∞ and K estimated in the present study are comparable to those obtained previously for red mullet in the Saronikos Gulf by the analysis of age data (Papaconstantinou, Tsimenidis and Daoulas, 1981, in Table 2). In addition the estimates of total mortality values for the two years of study (1985-86) were close. This can be taken as indicative of steady conditions in the fish stock during that period.

Concerning the "integrated" method of Pauly (1983) for determining the growth parameters, it is noted that this method appears to be applicable in the case of red mullet, particularly because this species has a relatively short spawning period around May and consequently the length modes are expected to correspond to year classes. However, it proved difficult to follow modes with time and the fits of growth curves were not always convincing. Although the method has been computerized (Pauly, 1987) fitting by eye may be more reliable as it is simply a matter of distinguishing modes progressing in time (Gulland, 1987).

A problem recognized in the present growth study is the uncertainty as to the early growth and consequently to the value of the parameter K. The reason is that few small red mullet (below 100 mm) are present in the commercial trawl catches to be included in the analysis. Red mullet spend a part of their early life in semipelagic state in shallow warmer waters favouring fast growth before they settle on the bottom and move to deeper areas (Haidar, 1970). It is felt that the estimated K value (0.1697) is small to represent this fast early growth. Further studies of growth of red mullet are needed with particular attention on the early life by catching small fish in their habitat.

The uncertainty about the value of K is carried over to all further analysis, since this value in the present study is involved in the estimation of all the parameters used as inputs in the relative yield per recruit model. The confidence in the results is also limited because of the use of an M value computed from the empirical formula of Pauly, which can give only rough estimates of M.

The assessment attempted by the use of parameter values derived from our data (Figure 8) indicates that the stock of red mullet in the Saronikos Gulf is not fully exploited. However, as

this finding suggests fishing harder for a stock that from common sources appears to be heavily fished, it is an additional cause for caution concerning the reliability of the assessment.

The analysis then proceeded a step further by an examination of the sensitivity of the assessment to changes in the values of the input parameters K and M. The computations with different reasonable combinations of these values revealed a great variation in the relative positions of $E_{current}$ and $E_{0.1}$ on the yield curve. Totally different conclusions coud be drawn about the state of exploitation of the stock under study. Clearly, the relative yield per recruit approach can not be applied, unless more refined estimates of the key parameters are obtained. Such estimates, if possible, should be derived from independent sources.

Finally, it should be noted that the yield per recruit model in its classical form has some weaknesses, of which an important one is that it takes recruitment as independent of parent stock (Pitcher and Hart 1982, Cushing 1981). For this reason, calculations of yield per recruit, without any information on the effect of fishing on recruitment, can be very misleading.

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Table 1

Length frequency distribution (%) of red mullet (Mullus barbatus) in the Saronikos gulf used for computing L_{oo} and Z/K

Mid-point of length class L_i (mm) \ Sampling month	1985 A	1985 M	1985 J	1985 O	1985 N	1986 A	1986 M	1986 J	1986 S	1986 O	1986 N	$\Sigma \frac{\%}{n_a)}$	$\bar{L}_i$
75				0.5	0.1							0.05	134.50
85				6.5	0.6				3.2	1.5		1.07	134.55
95		1	1.7	11.4	1.1		1.6	2.2	12.3	2.9	0.8	3.18	135.08
105	.1.1	0.6	.5.5	18.0	2.8	2.9	8.5	8.1	.26.4	10.3	. 0.0	7.65	136.42
115	4.3	11.7	15.4	10.1	9.1	12.5	18.4	30.6	17.2	18.8	8.8	14.26	139.14
125	12.3	16.4	21.1	10.9	18.9	27.8	17.4	22.2	7.3	26.8	15.1	17.84	143.81
135	21.1	12.0	22.1	12.9	19.6	30.2	13.7	15.4	16.4	18.2	17.9	18.14	149.81
145	24.7	22.9	13.7	8.8	15.8	15.7	15.3	11.0	9.4	9.3	28.3	15.90	156.92
155	16.1	18.9	11.1	8.3	12.6	2.8	8.6	5.4	3.2	5.4	14.3	9.70	165.57
165	12.8	5.1	4.6	5.2	8.5	3.6	6.5	2.2	2.1	2.5	9.5	5.69	173.98
175	6.0	8.0	2.8	2.6	7.1	2.5	5.6	1.8	1.1	2.9	3.6	4.00	181.83
185	1.3	0.6	0.5	3.5	1.2	1.1	1.9	1.0	1.5	1.5	1.7	1.44	192.73
195	0.2	1.3	1.5	0.7	1.5	0.5	1.4	0.0				0.64	203.13
205		0.3		0.5	0.4	0.3	0.8	0.0				0.21	215.23
215				0.0	0.4		0.0	0.0				0.04	225.00
225		1.0		0.0	0.0		0.4	0.1				0.14	227.22
235				0.1	0.4							0.04	235.00

a) n: The number of sampling months

Table 2

Calculation of the quantity Q' for red mullet (Mullus barbatus)

Area studied	Sex	Loo (cm)	K	Reference	Q' = logK + 2logLoo Loo: Total length
Gulf of Lions (France)	♂♂	22.50	0.560	Passelaigue,1974 as recorded in Dremiere,1981	2.4525
	♀♀	24.50	0.600		2.5565
Saronikos Gulf (Greece)	♂♂	21.12	0.191	Papaconstantinou et al. 1981	1.9304
	♀♀	26.77 1)	0.135		1.9856
Sicilian Channel (Italy)	♂♂	23.39	0.158	Andaloro and Prestipino Giarritta, 1985	1.9367
	♀♀	24.55	0.225		2.1323
Patraikos Gulf (Greece)	♂+♀	23.31	0.049	Papaconstantinou et al. 1986	1.4253
Korinthiakos Gulf (Greece)	♂+♀	21.49	0.038	Papaconstantinou et al. 1986	1.2442
Ionian Sea (Greece)	♂+♀	22.85	0.043	Papaconstantinou et al. 1986	1.3512
Eastern Adriatic (Yugoslavia)	♂+♀	27.00	1.800	Jukic and Piccinetti (in press)	3.1180
					$\bar{Q}'$ = 2.0133

1) Converted to total length according to factor given in the report

Table 3

Data for the construction of a catch curve of the year 1985 for red mullet (Mullus barbatus) in the Saronikos Gulf

Class limits		Midpoint 1)	N	t_1 2)	t_2 2)	Δt	Adjusted number per length class ln N/Δt	Relative age of midpoint 2)	Remarks
lower 1)	upper 1)								
70.01	80.00	75.01	2	1.924	2.258	0.334	1.790	2.089	
80.01	90.00	85.01	23	2.259	2.614	0.355	4.171	2.434	
90.01	100.00	95.01	44	2.614	2.993	0.379	4.754	2.801	
100.01	110.00	105.01	89	2.993	3.397	0.404	5.395	3.192	Not used, ascending part curve
110.01	120.00	115.01	143	3.398	3.833	0.435	5.795	3.611	
120.01	130.00	125.01	242	3.833	4.303	0.470	6.244	4.063	
130.01	140.00	135.01	274	4.303	4.814	0.511	6.284	4.553	
140.01 3)	150.00	145.01	269	4.815	5.375	0.560	6.174	5.089	
150.01	160.00	155.01	205	5.376	5.996	0.620	5.801	5.678	
160.01	170.00	165.01	123	5.996	6.690	0.694	5.177	6.333	Portion used for estimating Z
170.01	180.00	175.01	66	6.691	7.479	0.788	4.428	7.072	
180.01	190.00	185.01	23	7.480	8.392	0.912	3.228	7.919	
190.01	200.00	195.01	14	8.393	9.474	1.081	2.561	8.909	
200.01	210.00	205.01	6	9.475	10.805	1.330	1.506	10.103	
210.01	220.00	215.01	2	10.806	12.532	1.726	0.147	11.606	
220.01	230.00	225.01	1	12.534	14.997	2.463	-0.901	13.637	Not used
230.01	240.00	235.01	3	15.00	19.355	3.355	-0.112	16.782	

1) Total length in mm

2) Computed by means of the equation: $t-t_o = \ln(1-\frac{l_t}{L_{oo}})/- K$ with $t_o = 0$ and L_{oo}, K. the Von Bertalanffy parameters

3) The smallest length of fish fully represented in the catches

Table 4

Data for the construction of a catch curve of the year 1986
for red mullet (Mullus barbatus) in the Saronikos Gulf

Class limits		Midpoint[1]	N	t_1[2]	t_2[2]	Δt	Adjusted number per class ln N/Δt	Relative age of midpoint[2]	Remarks
lower[1]	upper[1]								
80.01	90.00	85.01	6	2.259	2.614	0.355	2.827	2.434	
90.01	100.00	95.01	26	2.614	2.993	0.379	4.228	2.801	Not used.
100.01	110.00	105.01	100	2.993	3.397	0.404	5.511	3.192	→ ascending part of curve
110.01	120.00	115.01	227	3.398	3.833	0.435	6.257	3.611	
120.01	130.00	125.01	286	3.833	4.303	0.470	6.411	4.063	
130.01[3]	140.00	135.01	283	4.303	4.814	0.511	6.317	4.553	
140.01	150.00	145.01	248	4.815	5.375	0.560	6.093	5.089	
150.01	160.00	155.01	125	5.376	5.996	0.620	5.306	5.678	Portion used
160.01	170.00	165.01	90	5.996	6.690	0.694	4.865	6.333	→ for estimating Z
170.01	180.00	175.01	58	6.691	7.479	0,788	4.299	7.072	
180.01	190.00	185.01	22	7.480	8.392	0.912	3.183	7.919	
190.01	200.00	195.01	11	8.393	9.474	1.081	2.320	8.809	
200.01	210.00	205.01	5	9.475	10.805	1.330	1.324	10.103	
210.01	220.00	215.01	1	10.806	12.532	1.726	- 0.545	11.606	→ Not used
220.01	230.00	225.01	4	12.534	14.997	2.463	0.485	13.637	

1), 2), 3), as in Table 3

Table 5

Derivation of a "selection" curve from the left side of a length-converted catch curve of the year 1985 for red mullet (M. barbatus) in the Saronikos Gulf

Midpoint of length class	Numbers caught (N_i)	Δt midpoint to midpoint b)	Mortality I ($M \rightarrow Z$) c)	Mortality II (means)	Numbers available N_i/P_i d)	$P = N_i/N_i/P_i$	Cumulative P	% Cumulative e)
65.01	0	——	M=0.455	——	0	0	0	0
75.01	2	0.345	0.517	0.547	2557	0.0008	0.0008	0.04
85.01	23	0.367	0.578	0.609	2117	0.0109	0.0117	0.52
95.01	44	0.391	0.640	0.671	1693	0.0260	0.0377	1.68
105.01	89	0.419	0.702	0.733	1302	0.0684	0.1061	4.74
115.01	143	0.452	0.764	0.794	958	0.1493	0.2554	11.40
125.01	242	0.490	0.825	0.856	669	0.3617	0.6171	27.55
135.01	274	0.535	0.887	0.918	440	0.6227	1.2398	55.35
145.01	269 a)		Z=0.949		269	1.00	2.2398	100

a) This number may be taken as the actual number caught in the first length class that is fully selected (i.e. the length corresponding to P_1).

b) Computed from $\Delta t = (1/-K)\ln [(L_{oo}-L_2)/ (L_{oo} - L_1)]$ where L_1, L_2 are the lower and upper limits of a given length class, respectively.

c) Values between Z and M interpolated linearly.

d) Computed from $N_i/P_i = N_{i+1} / P_{i+1} e^{z\Delta t}$, where N_{i+1}/P_{i+1} is the number available in a legth class and N_i/P_i the number available in the next lower length class.

e) The length which corresponds to P=0.5 (i.e. to 50% of the cumulated possibilities) is obtained through interpolation between 125.01 and 135.01 mm; it is L'_c = 133.09 mm.

Table 6

Derivation of a "selection" curve from the left side of a length-converted catch curve of the year 1986 for red mullet (M. barbatus) in the Saronikos Gulf

Midpoint of length class	Numbers caught (N_i)	Δt midpoint to midpoint b)	Mortality I ($M \rightarrow Z$) c)	Mortality means	Numbers available N_i/P_i d)	$P = N_i/N_i/P_i$	Cumulative P	% Cumulative e)
75.01	0	——	M=0.455	——	0	0	0	
85.01	6	0.367	0.534	0.573	1366	0.0044	0.0044	0.20
95.01	26	0.391	0.613	0.652	1107	0.0235	0.0279	1.29
105.01	100	0.419	0.692	0.731	858	0.1165	0.1444	6.69
115.01	227	0.452	0.771	0.811	632	0.3592	0.5036	23.35
125.01	286	0.490	0.851	0.890	438	0.6530	1.1566	53.63
135.01	283 a)		0.930		283	1.00	2.1566	100

a), b), c), d), as in Table (5).

Table 7

Summary of values of pupulation parameters for red mullet (Mullus barbatus) in the Saronikos Gulf, Greece (1985-1986)

	L_{oo} (mm)	K	Z/K	Z	M	$F=\bar{Z}-M$	$E=\frac{F}{F+M}$	$\bar{L}'_c$ (mm)	M/K	$c=\frac{\bar{L}'_c}{L_{oo}}$
Pauly, 1983	248.99	0.1716								
Wetherall et al.,1987	247.85		6.0480							
Wetherall et al.,1987 and Pauly and Munro 1984		0.1678		1.015						
Catch curve, Pauly, 1983a				0.940 a)						
Beverton and Holt, equation				0.852 a)						
	$\bar{L}oo^{b)}$ = 248.42	$\bar{K}^{b)}$ = 0.1697		$\bar{Z}$ = 0.936						
Pauly's empirical equation,1980					0.455					
						0.481	0.514			
Resultant curve, Pauly, 1984								128.45		
									2.68	0.52

a) The mean of the values estimated for the years 1985 and 1986

b) Mean value

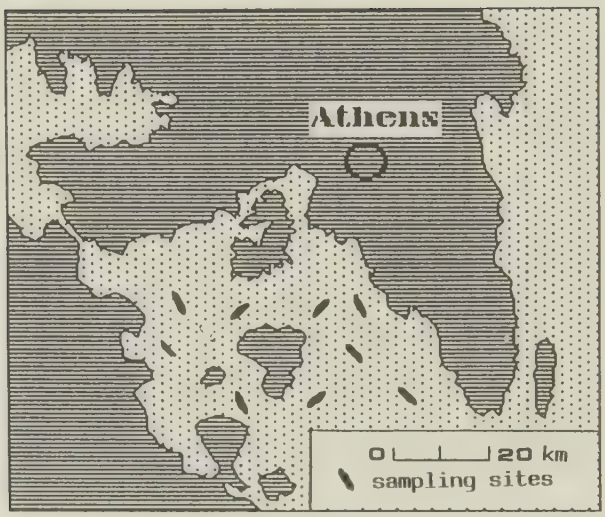

Figure 1 Map of the Saronikos Gulf, Greece, and sampling sites

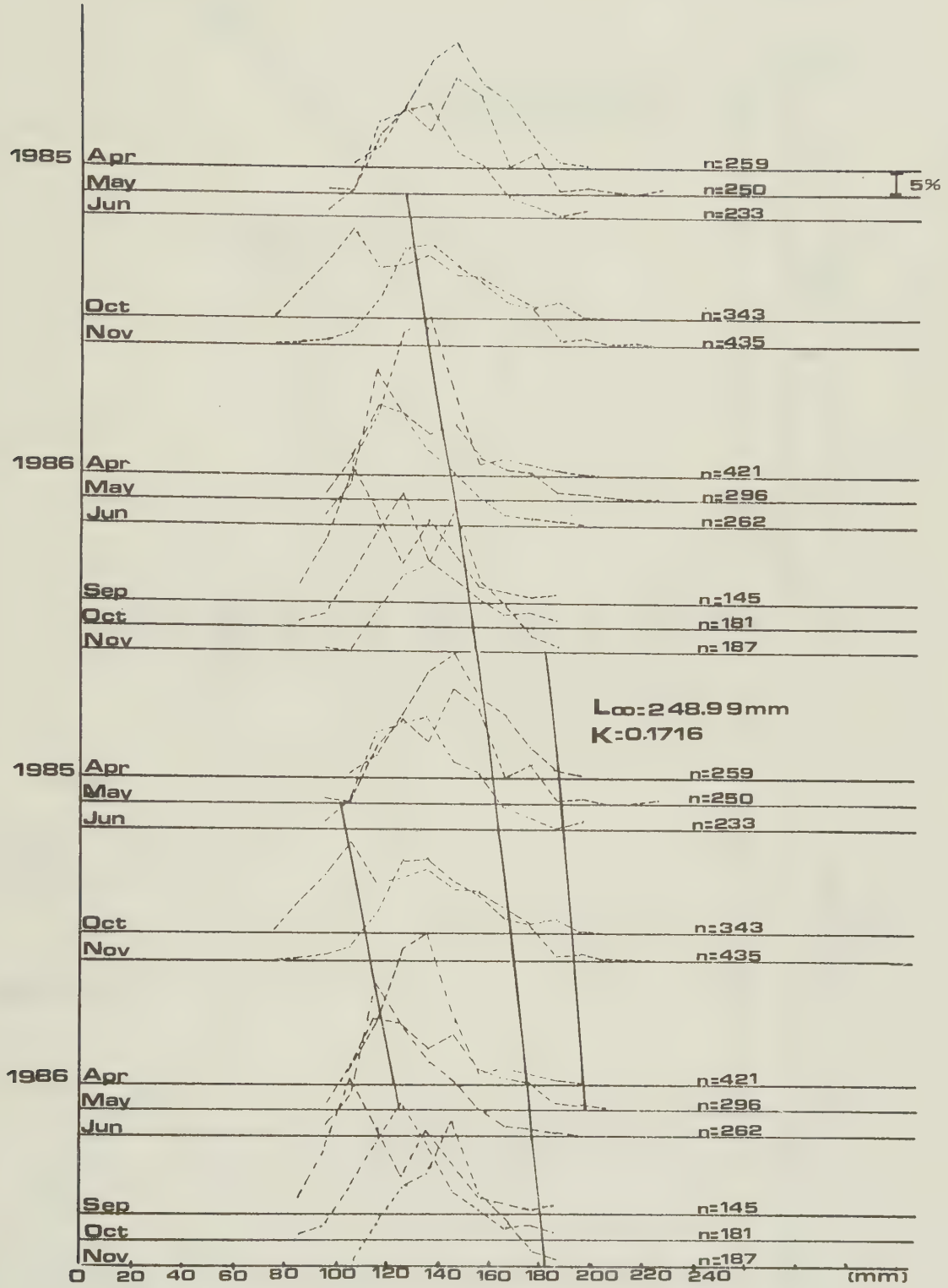

Figure 2 Growth curve of red mullet (Mullus barbatus) in the Saronikos Gulf, Greece (Males and females: 1985-1986)

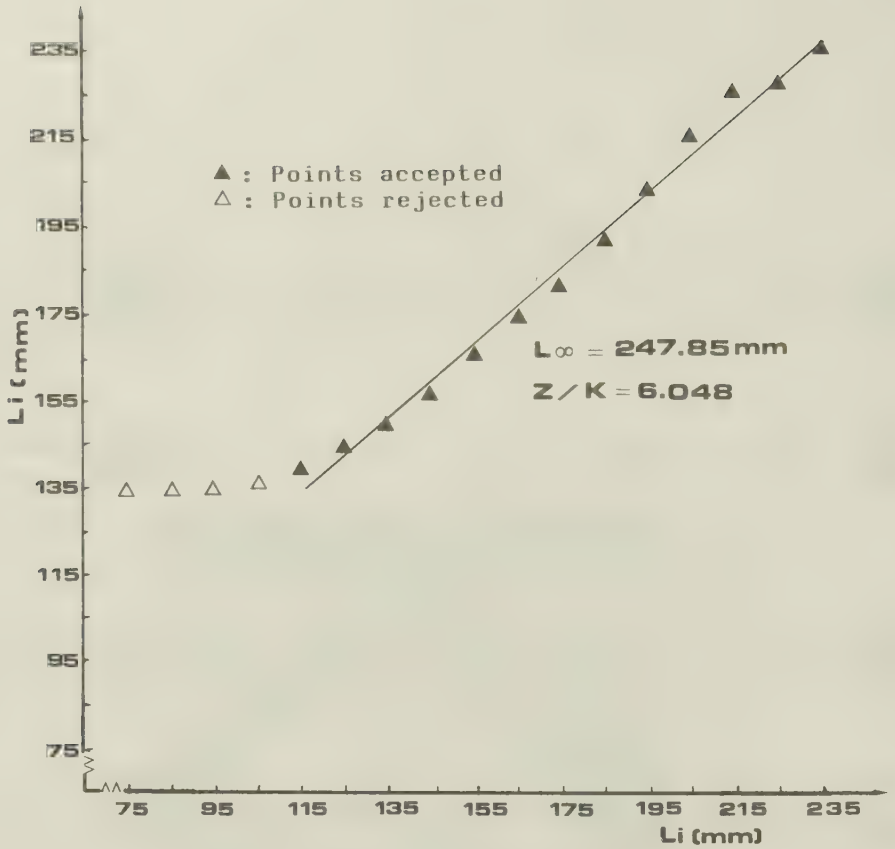

Figure 3 Determination of L_{oo} and Z/K for Mullus barbatus in the Saronikos Gulf, Greece (1985-86)

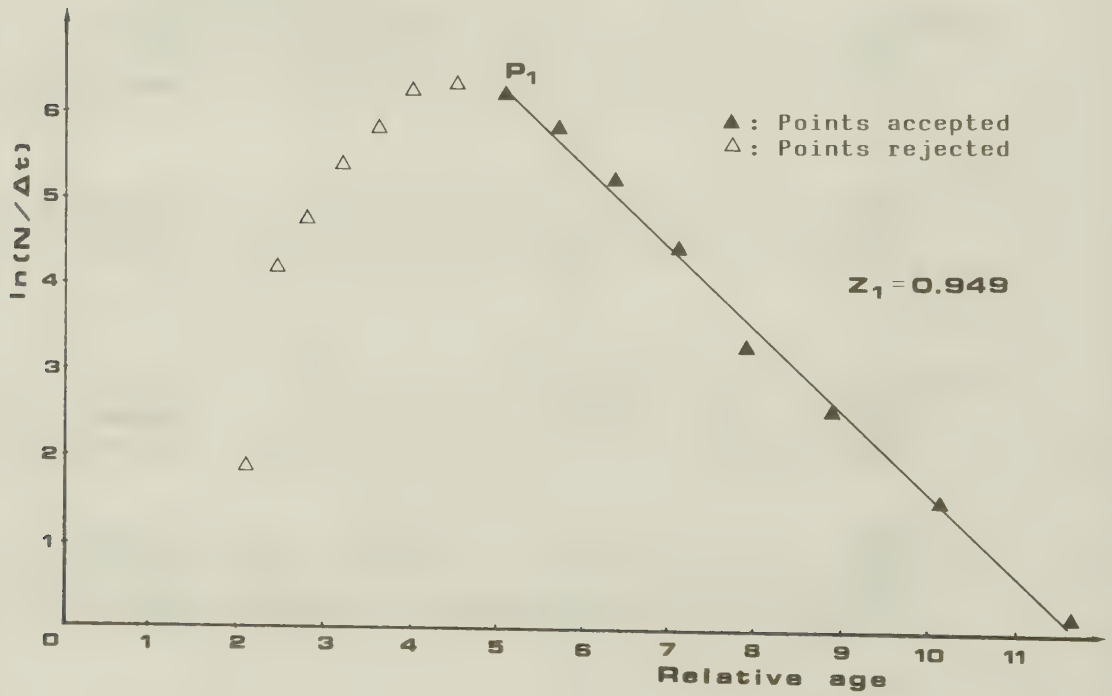

Figure 4 Length-converted catch curve of the year 1985 for red mullet (Mullus barbatus) in the Saronikos Gulf, Greece

P_1 corresponds to the mid-point of the smallest length class full represented in the catches

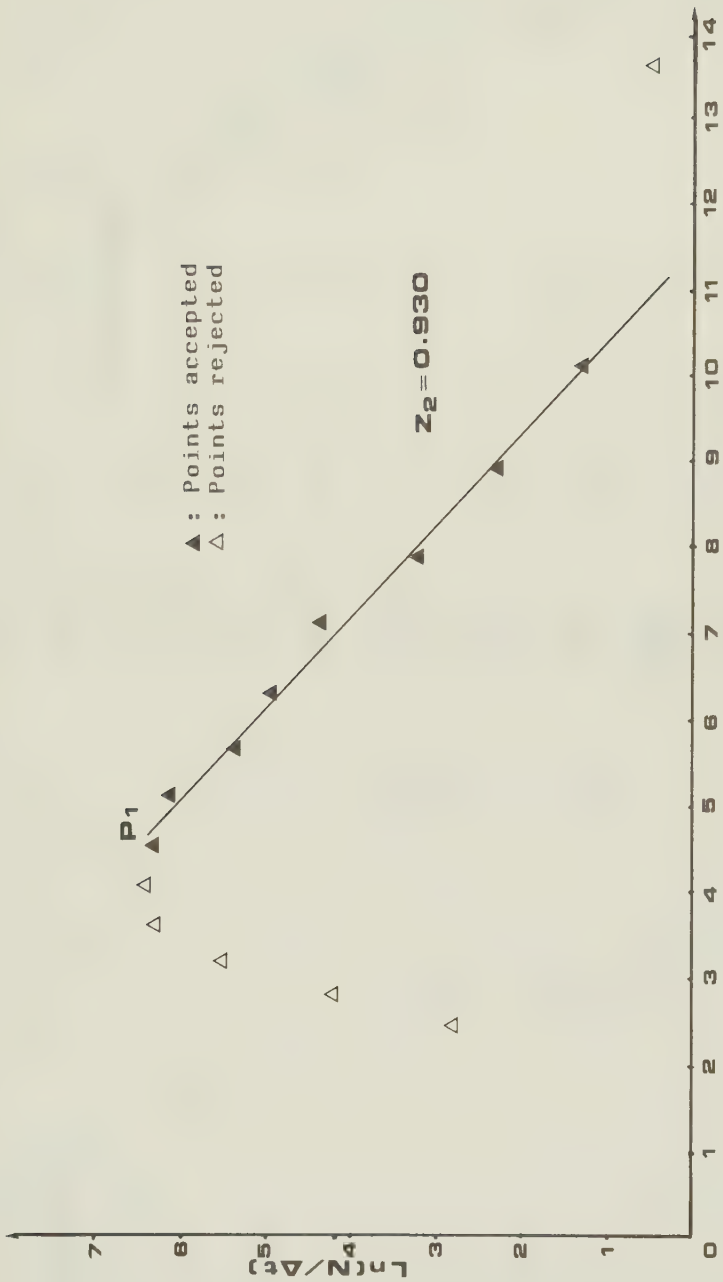

Figure 5 Length-converted catch curve of the year 1986 for red mullet (Mullus barbatus) in the Saronikos Gulf
P_1 as in Figure 4

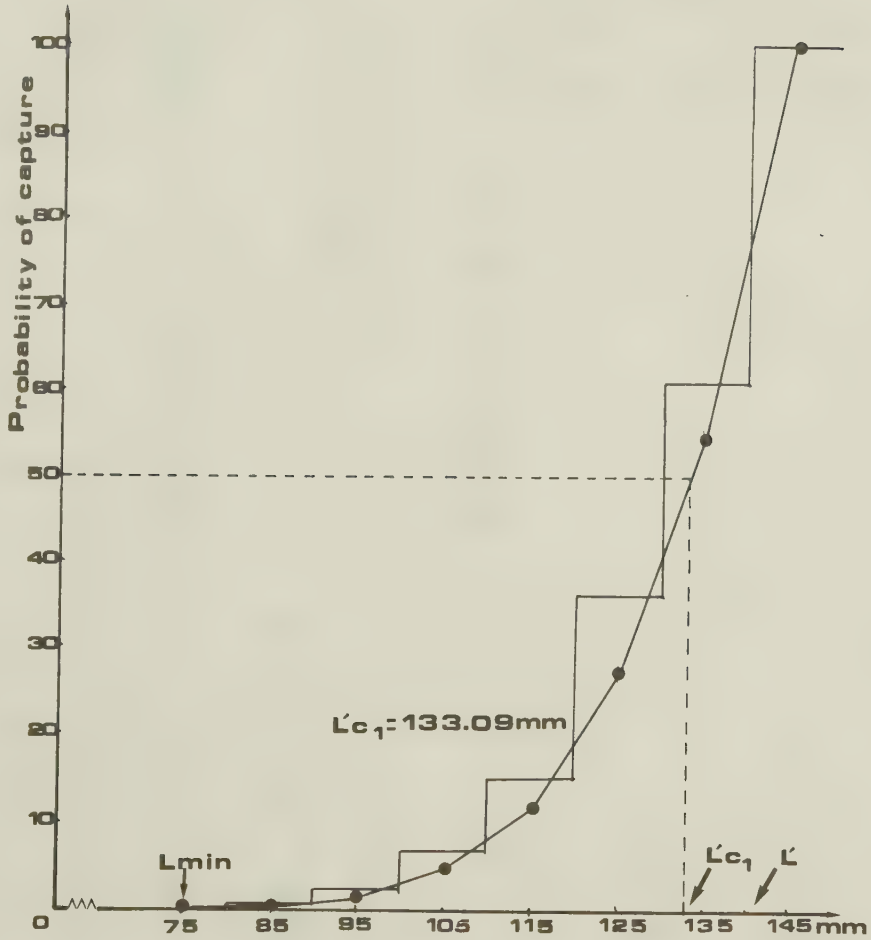

Figure 6 Probability of capture and resultant curve of Mullus barbatus in the Saronikos Gulf, Greece (1985)

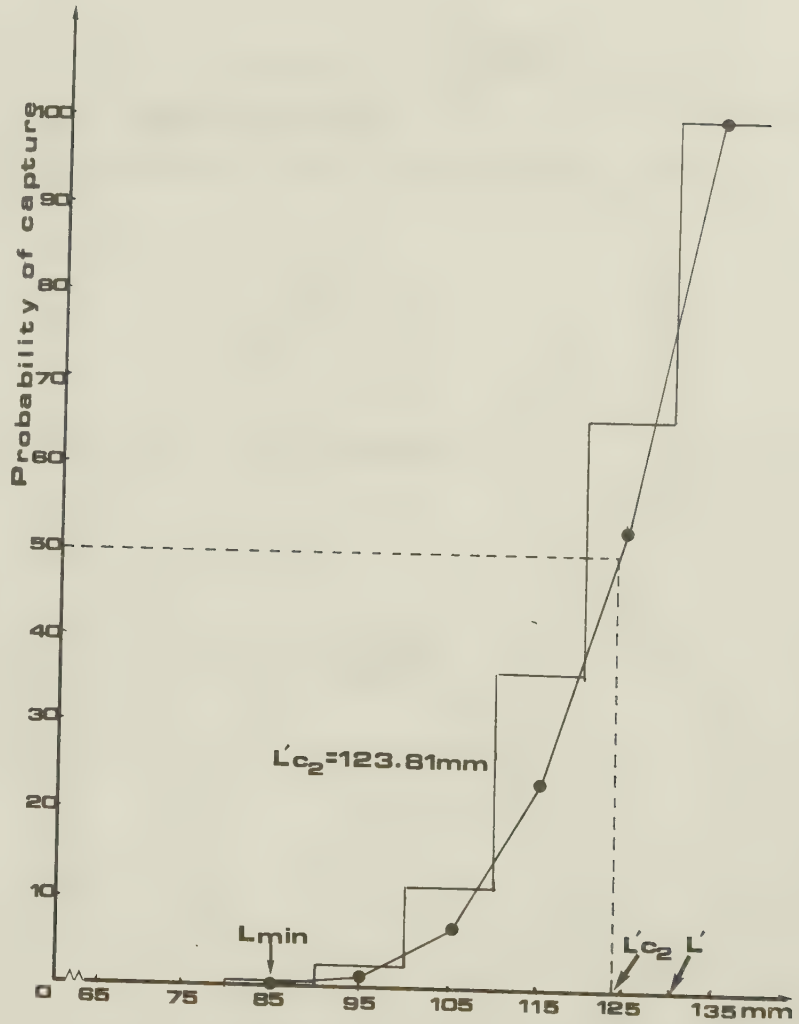

Figure 7 Probability of capture and resultant curve of Mullus barbatus in the Saronikos Gulf, Greece (1986)

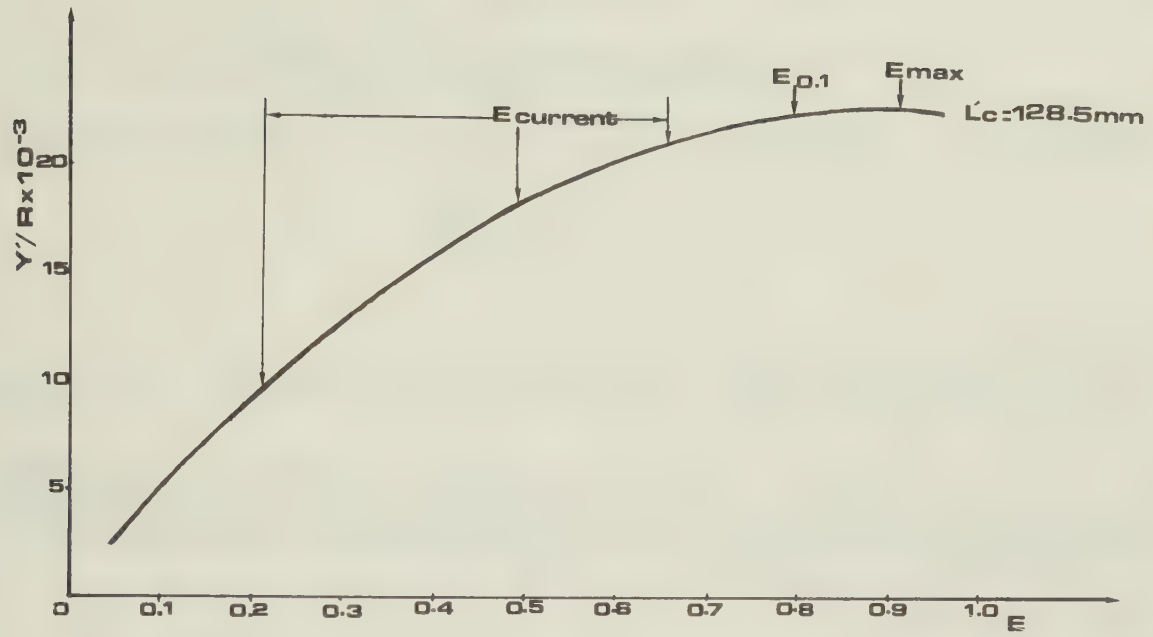

Figure 8 Relative yield per recruit (Y'/R) as a function of exploitation rate (E) for Mullus barbatus in the Saronikos Gulf, Greece (M/K = 2.5)

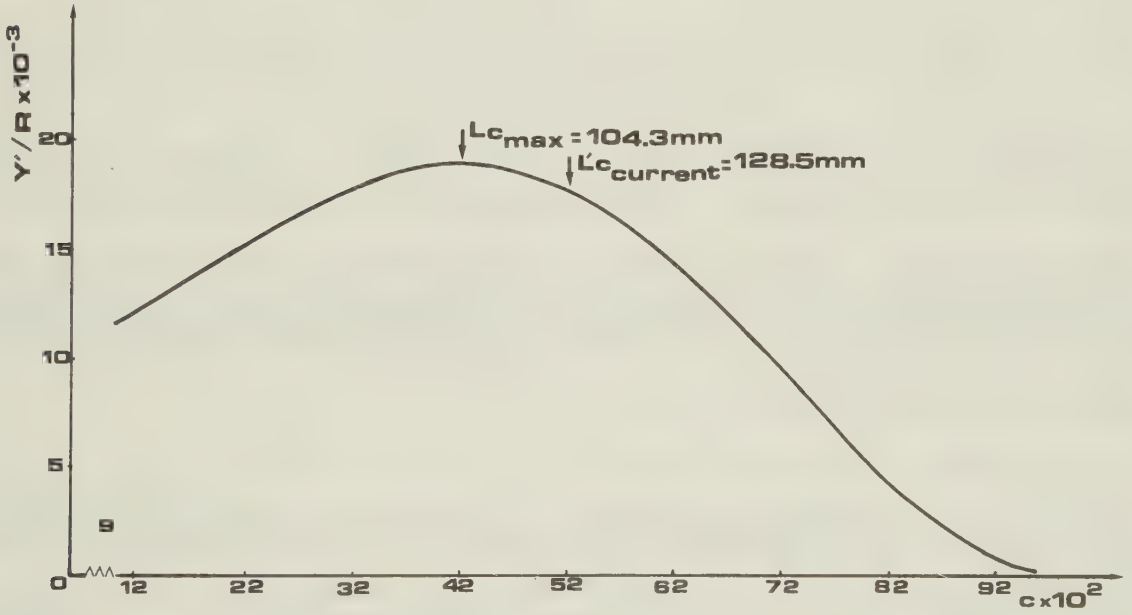

Figure 9 Relative yield per recruit (Y'/R) as a function of length (relative) at first capture ($c = \frac{L'}{L_{oo}}$) for red mullet Mullus barbatus in the Saronikos Gulf, Greece (M/K) = 2.5, E = 0.50)

APPENDIX/ANNEXE E

A Study of the Growth and Maturity of Striped Mullet (Mullus barbatus L), in Waters of Cyprus

by

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1. INTRODUCTION

Family Mullidae is represented in the seas of Cyprus by three species: Mullus barbatus L, Mullus surmuletus L, Upeneus molucensis Bleeker.

Of these three species, only the first two are commercially important. Mullus barbatus comes second quantitatively in commercial importance in the catch of trawl fishery after Maena smaris, and represented 10.7% of the average annual catch of the trawl fishery for the seven years 1976-82. It rated fifth in significance in the catch of the inshore fishery (5.5%) for the same period. The annual average for the whole catch (trawl and inshore) is 7%.

2. MATERIALS AND METHODS

A total number of 33 945 fish were measured for length distributions during the years 1965-83 on board commercial trawlers during fishing operations, and on the research vessel TRITON of the Fisheries Department during survey, as well as at the landing places of the inshore boats.

Six hundred specimens from various areas around the island were used to construct the length-weight key of M. barbatus. Another lot of 328 specimens, collected from 1970 to 1973, were transferred to the laboratory of the Fisheries Department for analysis of population characteristics.

Fishing Gear. The fishing gear in use by the sterntrawlers in Cyprus, is the commom bottom otter trawl in use in the Eastern Mediterranean. It has a codend of 32 mm stretched mesh opening, when measured by an ICES mesh gauge at 4 kg pressure. The fishing gear used in the inshore fishery for striped mullet is the trammel net, a bottom stationary gear of 32 mm stretched mesh opening.

Length Measurements. The length of fish in the laboratory and on fishing vessels was measured on a measuring board consisting of a wooden board, carrying a center scale marked in 1-cm and 1/2 cm intervals, with a head piece at one end. Overall length measured is the total length (LT), from the tip of the lower jaw to the tip of the lower caudal fin, both lobes pressed together.

Measurements were taken to the 1/2 or 1 cm below, and then grouped in 1-cm units for length frequency distribution and length-weight relation.

Weight of fish was measured on an electric torsion balance to the nearest 0.5 g.

Determination of Maturity Stage of Gonads. For this purpose the gonads were examined fresh under a stereomicroscope and were classified according to the classification scale of Naier (I-VIII).

Age Determination. Age of striped mullet was determined from otoliths and partly from scale readings. Otoliths were examined under a microscope with reflected light against a dark background and the scales under a microscope with transmitted light. From 76 fish whose scales were examined, only 14 were aged; the scale readings of 62 specimens were doubtful. Out of 209 pairs of otoliths examined, those of 163 fish were clearly readable and 46 doubtful.

Age Designation. The first year-ring of the newly born M. barbatus starts its formation on the edge of the otolith in February/March of the year following its birth, i.e., on the 9th/10th month of its first year of life. The year-ring is completed by the end of the 12th month. Up to the 9th month it is considered to belong to the 0-group. From the 10th month to the 21st month, when the second year-ring begins its formation on the edge of the otolith, it is considered to belong to the I-group and so forth. This relation is shown in the Table below up to age group IV.

	Age groups				
	0	I	II	III	IV
Months old	0-9	10-21	22-33	34-45	46-57
Annuli	0	1	2	3	4

This age designation agrees with the age designation by Gharbi and Ktari (1981), Chugunova (1959) and Williams and Bedford (1973).

3. RESULTS AND DISCUSSIONS

Length-weight Relation. Tables 1 and 2 give the mean weight for each 1-cm length interval of striped mullet. The mathematical relation of length-weight of striped mullet is as follows:

M+F: $W = 1.288 \times 10^{-2} \cdot L^{2.94}$

M: $W = 5.16145 \times 10^{-3} \cdot L^{3.33}$

F: $W = 1.5789 \times 10^{-2} \cdot L^{3.04}$

Growth in M. barbatus could be considered almost isometric, in view of the very small divergence of b = 2.94 from 3. The same applies for females, while the growth of males is allometric.

4. GROWTH BY LENGTH AND WEIGHT

(i) Growth by Length. Generally the absolute growth in length exhibits an initial period of rapid increases in length, followed by a decrease. This relation is shown in Table 3.

The growth of male and female M. barbatus show a clear differential growth in the two sexes from age II upwards; the faster growth observed in the female fish, which reach greater lengths than the male of the same age.

(ii) Von Bertalanffy Growth Formula (VBGF)

The two parameters L_{oo} and K were estimated by the Ford/Walford plot, and t_o by plotting $\log_e \frac{L_{oo} - l_t}{L_{oo}}$ against t on semilogarithmic paper.

The three parameters L_{oo}, K, and t_o of Mullus barbatus are:

M+F $L_{oo} = 25$ cm $K = 0.27$ $t_o = -1.2$

M $L_{oo} = 22$ cm $K = 0.24$ $t_o = -1.2$

F $L_{oo} = 28.4$ cm $K = 0.18$ $t_o = -1.1$

Maximum Age. It has been demonstrated by various authors that the value of K in VBGF in fishes is closely linked with longevity. Generally in nature, the oldest fishes of a stock grow to reach about 0.95 of their asymptotic length (Beverton, 1963). Thus from von Bertalanffy equation we get:

$$t_{max} = \frac{3}{K} + t_o$$

and for Mullus barbatus:

M+F $t_{max} = 9.8$ years; M $t_{max} = 11.3$ years; F $t_{max} = 15.6$ years.

The mean length for each age-group of M. barbatus obtained from the VBGF up to age-group X is as follows:

Age groups	I	II	III	IV	V	VI	VII	VIII	IX	X
Mean length (cm)	11.30	14.57	17.06	18.96	20.4	21.5	22.34	23.0	23.46	23.82

(iii) Growth by Weight. The weight of an individual fish is assumed proportional to the cube of its length, so that from the von Bertalanffy equation we get:

$$W_t = W_{oo} [1-e^{-k(t-t_o)}]^3$$

where W_t = weight w at age t

W_{oo} = the asymptotic weight corresponding to the asymptotic length L_{oo} or $W_{oo} = aL^3_{oo}$

The W_{oo} values obtained for M. barbatus are the following:

M+F W_{oo} = 166 g, M W_{oo} = 152 g, F W_{oo} = 303 g.

Mean weights for each age of M. barbatus are given in Table 4.

5. MATURITY

(i) Age and Length of First Maturity. M. barbatus matures in its first year of life (11th-12th month) at a length of about 9-10 cm: both sexes simultaneously. This is shown in Tables 5 and 6.

(ii) Monthly Progress of Maturity Stages-Spawning Time

The process of maturity of gonads in M. barbatus starts not later than March, when already the majority of the population is in maturity stage III (72.5%). In May, when fish have completed one year of life, gonads are found in all stages III-VIII of maturity. A significant part of the population have already started spawning (19%); another part (12%) are in an advanced spawning. At the end of June (29th) most of the fish are in the spawning stages VI and VII, but there are still some in the prespawning stage (V). Spawning continues into July (Table 7).

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Table 1

Mean weight at each 1-cm length of M. barbatus, both sexes

Length (cm)	Range of weights (g)	Mean weight (g)	Number of specimens
5.0-5.9	0.9-1.9	1.4	16
6.0-6.9	1.6-3.7	2.3	29
7.0-7.9	2.7-4.9	3.7	34
8.0-8.9	4.1-7.7	5.7	27
9.0-9.9	6.6-9.7	8.5	28
10.0-10.9	8.8-14.7	12.2	31
11.0-11.9	11.0-18.1	15.0	58
12.0-12.9	12.4-24.3	18.0	91
13.0-13.9	18.4-30.5	23.3	77
14.0-14.9	24.8-35.6	29.3	52
15.0-15.9	31.9-38.5	36.0	45
16.0-16.9	42.6-52.9	46.3	33
17.0-17.9	48.2-64.7	58.0	24
18.0-18.9	59.6-72.7	67.8	18
19.0-19.9	67.8-80.4	74.0	27
20.0-20.9	77.7-93.2	85.8	7
21.0-21.9	97.9-114.2	106.0	3
Total			600

Table 2

Mean weight at each 1-cm length of M. barbatus
Sexes separate

Length (cm)	Mean weight (g)		Numbers		Range of weights	
	M	F	M	F	M	F
9.0- 9.9	7.0	-	2	-	-	-
10.0-10.9	14.9	13.2	7	2	11.0-21.0	13.0-13.5
11.0-11.9	15.8	19.3	18	5	13.0-19.0	14.0-19.0
12.0-12.9	20.0	21.4	14	9	17.0-23.5	18.0-25.0
13.0-13.9	27.5	27.5	8	14	20.0-30.5	21.0-33.0
14.0-14.9	32.8	34.1	18	14	28.5-36.0	29.0-40.0
15.0-15.9	40.0	42.5	24	9	34.0-47.0	38.5-45.0
16.0-16.9	47.7	48.4	13	11	38.5-57.5	42.5-56.0
17.0-17.9	58.9	59.5	4	5	55.0-63.0	55.5-65.0
18.0-18.9	73.0	81.2	2	5	72.0-74.0	76.5-89.0
19.0-19.9	-	91.0	-	2	-	91.0-91.0

Table 3

Mean length at each age-group of M. barbatus

Age groups	0	I		II		III		IV	
	M/F	M	F	M	F	M	F	M	F
L (cm)	-	11.5	11.5	13.2	13.0	15.9	16.2	17.5	18.9
Range of lengths	M - F -	9-13	-	11.0-15.0 10.5-15.5		15.0-17.5 15.0-18.0		16.5-18.0 18.5-19.5	
N	-	11	1	29	28	20	10	3	5
L (cm)	8.2	11.5		13.1		16.0		18.2	
Range of lengths	6-10	9.0-13.0		10.5-15.5		15.0-18.0		16.5-19.5	
N	56	12		57		30		8	

Table 4

Mean weight at each age-group of M. barbatus

Age groups	0		I		II		III		IV	
	M	F	M	F	M	F	M	F	M	F
Mean weight (g)	-	-	15.3	13.5	27.2	25.7	47.7	52.2	65.6	86.5
Range of weights	M - F -		11.0-18.5 -		14.0-45.0 13.0-45.0		34.5-63.0 42.0-77.0		51.0-74.0 76.5-91.0	
N	-		11	1	29	28	20	10	3	5
M+F										
Mean weight (g)	7.0		15.12		26.50		49.20		78.70	
Range of weights	3.0-12.0		11.0-18.5		13.0-45.0		34.5-77.0		51.0-91.0	
N	56		12		57		30		8	

Table 5

Age-maturity stage relation of M. barbatus

Maturity stages		I		II		III		IV	
		M	F	M	F	M	F	M	F
II	N	-	-	-	-	1	-	-	-
	%	-	-	-	-	3.3	-	-	-
III	N	-	-	11	1	9	-	1	-
	%	-	-	19.3	1.8	30.0	-	12.5	-
IV	N	-	-	5	4	3	3	2	3
	%	-	-	8.8	7.0	10.0	10.0	25.0	37.5
V	N	1	-	1	5	6	2	-	2
	%	8.4	-	1.8	8.8	20.0	6.6	-	25.0
VI	N	8	-	4	12	1	5	-	-
	%	66.6	-	7.0	21.0	3.3	16.6	-	-
VII	N	2	1	6	5	-	-	-	-
	%	16.6	8.4	10.5	8.8	-	-	-	-
VIII	N	-	-	2	1	-	-	-	-
	%	-	-	3.5	1.8	-	-	-	-
Total		100%		100.1%		99.8%		100%	

Table 6

Length-maturity stage relation in M. barbatus L

Length (cm)		II	III		IV		V		VI		VII		VIII	Total
		M	M	F	M	F	M	F	M	F	M	F	M	
9	N	-	-	-	-	-	-	-	1	-	-	-	-	1
	%	-	-	-	-	-	-	-	100.0	-	-	-	-	100
10	N	-	-	-	1	-	1	-	5	-	-	2	-	9
	%	-	-	-	11.1	-	11.1	-	55.5	-	-	22.2	-	99.9
11	N	-	1	-	3	-	-	-	6	2	5	2	2	21
	%	-	4.7	-	14.3	-	-	-	28.6	9.5	23.8	9.5	9.5	99.9
12	N	-	2	1	4	1	2	3	4	5	1	-	1	24
	%	-	8.3	4.2	16.7	4.2	8.3	12.5	16.7	20.8	4.2	-	4.2	100
13	N	-	2	-	-	7	2	3	2	5	1	-	-	22
	%	-	9.1	-	-	31.8	9.1	13.6	9.1	22.7	4.5	-	-	99.9
14	N	-	9	-	6	6	2	6	-	5	-	-	-	34
	%	-	26.5	-	17.6	17.6	5.9	17.6	-	14.7	-	-	-	99.9
15	N	1	11	1	4	7	3	4	2	4	1	-	-	35
	%	2.6	28.9	2.6	10.5	18.4	7.9	10.5	5.2	10.5	2.6	-	-	99.7
16	N	-	8	-	2	8	2	5	3	1	-	-	-	29
	%	-	27.6	-	6.9	27.6	6.9	17.2	10.3	3.4	-	-	-	99.9
17	N	-	1	-	-	5	1	3	2	1	1	-	-	14
	%	-	7.1	-	-	35.7	7.1	21.4	14.3	7.1	7.1	-	-	99.8
18	N	-	-	-	1	6	1	1	-	-	-	-	-	9
	%	-	-	-	11.1	66.7	11.1	11.1	-	-	-	-	-	100
19	N	-	-	-	-	1	-	1	-	-	-	-	-	2
	%	-	-	-	-	50.0	-	50.0	-	-	-	-	-	100

Table 7

Monthly progress of maturity stages in M. barbatus

M A R C H 22nd											
Age groups	II		III		IV						
	M	F	M	F	M	F					
Numbers	1	-	29	-	10	-					
%	2.5	-	72.5	-	25.0	-					
M A Y 12th											
Age groups	III		IV		V		VI		VII		VIII
	M	F	M	F	M	F	M	F	M	F	M
Numbers	1	2	11	19	10	26	13	7	10	3	3
%	.95	1.90	10.5	18.1	9.5	24.75	12.4	6.66	9.5	2.85	2.85
J U N E 29th											
Age groups	V		VI		VIII						
	M	F	M	F	M	F					
Numbers	-	1	10	17	-	3					
%	-	3.22	32.25	54.84	-	9.68					

APPENDIX/ANNEXE F

The Growth and Maturity of Bogue (Boops boops L) Family Sparidae, in Waters of Cyprus

by

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1. INTRODUCTION

Boops boops L, common name bogue, is a member of the family Sparidae, one of the most numerous families in the seas of Cyprus. This species is of considerable importance in the fishing industry, being the predominant species in the catch of the inshore fishery, with an average of 16% over 5 years (1980-84) of a total catch of 5 232 t, and an average of 12.7% of the total catch (trawl and inshore) of 6 920 t, over the same period. This shows the importance of bogue for the inshore fishery, taking into consideration that over 45 species of fish are landed by this fishery.

2. MATERIALS AND METHODS

The procedures used in the foregoing paper in this volume by the same author on Mullus barbatus were followed.

A total number of 6 800 specimens were measured for length distribution on board commercial trawlers, during fishing operations and at the landing places of inshore boats. Of these, a number of 535 fish were taken to the laboratory of the Fisheries Department for analysis of population characteristics. The fishing gear used by the inshore fishery for bogue is the bottom gillnet of 38 mm mesh opening.

The majority of both otoliths and scales were clearly readable and the annual rings were quite discernible with only a small percentage doubtful.

Age designation. The first annulus (year-ring) starts forming on the edge of the otoliths and scales of the new-born fish in February, i.e., on the 10th month of its first year of life. The annulus is completed by the end of the 12th month. Thus it is considered that until the 9th month it belongs to the 0-group. From the 10th month, until the appearance of the 2nd annulus on the edge of otolith on the 22nd month, it belongs to the I-group. From the 22nd month until the 33rd month it belongs to the II-group and so forth. This relation is shown in the table below:

Age-Groups					
	0	I	II	III	IV
Months old	0-9	10-21	22-33	34-45	46-57
Annuli	0	1	2	3	4

This age designation is in agreement with the age designation by Chugunova (1959) and Williams and Bedford (1973).

3. RESULTS

Length-Weight relation. Mathematically, the length-weight relationship in the case of B. boops this relation is given by the equations:

$$M+F \quad W = 0.036521 \times L^{2.55}$$
$$M \quad W = 0.020180 \times L^{2.76}$$
$$F \quad W = 0.020730 \times L^{2.66}$$

Growth

Growth by length and weigth. Table 2 gives the mean length and weight at each age of B. boops.

The two parameters L_{oo} and K were estimated by Ford/Walford plot, and t_o was estimated by plotting $\text{Log}_e \frac{L_{oo} - l_t}{L_{oo}}$ against t on semilogarithmic paper.

By substituting the three parameters L_{oo}, K, and t_o in von Bertalanffy's growth equation with 24 cm, 0.53 and -0.45 respectively, we get the Bertalanffy growth function for B. boops.

Maximum age. Generally, in nature, the oldest fish of a stock grow to reach about 0.95 of their asymptotic length (Beverton, 1963). Thus from the von Bertalanffy growth equation we get, for B. boops:

$$t_{max} = \frac{3}{K} + t_o = 5.2 \text{ years}$$

Asymptotic weight. The weight of a fish is usually closely proportional to the cube of its length, and for W_{oo}, the asymptotic weight corresponding to the asymptotic length L_{oo}, $W_{oo} = aL_{oo}^b = 120$ g and $W_{max} = 0.86 \times W_{oo} = 103$ g.

Maturity

(i) Monthly progress of maturity stages. Monthly progress of maturity stages from January to May 1970 and from March to May 1971 and their frequencies, for male and female separately, are given in Table 3.

(ii) Age and length of first maturity. Age of fish at first maturity is shown in Figure 1. Lengths of fish at first maturity are given in Table 4.

4. DISCUSSION

Length-Weight relation. The growth in B. boops can be considered allometric as shown by the values of b=2.55, b=2.76, and b=2.66, which differ considerable from b=3.

Onset of maturity. B. boops matures sexually in its first year of life (Figure 1). At the age of 9 months, in January, and at a length of 12 cm it is in maturity stage II. In March some of the I-group fish have reached stage V, which is the prespawning stage. By the 21st of May all fish of I-group are in stage VIII (resting). Spawning most probably begins early in April, as in older age-groups, and continues throughout the month and most probably during the first half of May. Already some individuals of older age-groups have completed their spawning in april (stage VII). By the 25th of May, fish of all ages have completed spawning.

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Table 1

Mean weight at each length of Boops boops

Lengh cm	Mean weight, g			Numbers		
	F	M	M/F	F	M	M/F
12-12.9	21.8	20.1	20.7	5	5	17
13-13.9	25.0	24.1	24.5	21	12	52
14-14.9	28.9	28.3	28.4	20	19	56
15-15.9	35.0	35.4	35.4	19	23	48
16-16.9	41.6	40.9	41.3	26	24	50
17-17.9	51.1	47.9	49.6	25	22	48
18-18.9	57.5	59.1	58.4	14	16	30
19-19.9	68.8	65.4	67.2	14	15	30
20-20.9	81.0	75.6	78.4	9	8	17
21-21.9	90.7	90.0	90.4	2	2	4
22-22.9	104.0	108.0	105.0	3	1	4
Total				158	147	356

Table 2

Mean length and mean weight at each age-group

Age groups		F	M	F/M
I	Mean L (cm)	12	12.8	12.8
	Length range	12.0-13.5	11.5-13.5	11.5-13.5
	Mean W (g)	20.6	20.2	20.3
	Weight range	15.0-26.0	14.0-24.0	14.0-26.0
II	Mean L (cm)	14.8	14.6	14.7
	Length range	13.0-16.0	13.0-16.5	13.0-16.5
	Mean W (g)	31.7	29.2	30.5
	Weight range	20.0-44.0	20.0-43.0	20.0-44.0
III	Mean L (cm)	16.7	17.7	17.2
	Length range	15.0-20.0	15.0-19.5	15.0-20.0
	Mean W (g)	64.0	50.8	58.0
	Weight range	35.0-75.0	30.0-76.5	30.0-76.5
IV	Mean L (cm)	19.9	20.1	20.0
	Length range	17.0-22.0	18.5-22.0	17.0-22.0
	Mean W (g)	80.1	76.1	78.6
	Weight range	53.5-112.0	50.5-120.0	50.5-120.0

Table 3

Monthly progress of maturity stages (all age-groups) 1970-71

Month		I	II		III		IV		V		VI		VII		VIII		Total
		F/M			F	M	F	M	F	M	F	M	F	M	F	M	
Jan. 12	Nos	10	1														11
	%	90.9	9.1														100%
Jan. 21	Nos	9	6	14	4	10	33	14	15	1							106
	%	8.5	5.7	13.2	3.8	9.4	31.2	13.2	14.1	0.9							100%
Feb. 2	Nos			12	4	13	8	21	8	1							67
	%			17.9	6.0	19.4	11.9	31.3	11.9	1.5							99.9%
April 6	Nos					2	9	4	-	14	2	2					33
	%					6.1	27.3	12.1	-	42.4	6.1	6.1					100.1%
April 8	Nos				1	-	14	-	-	1	-	1	1				18%
	%				5.6	-	77.7	-	-	5.6	-	5.6	5.6				100.1%
April 29	Nos		1	-	4	6	10	11	7	4	3	-	1				47%
	%		2.1	-	8.5	12.8	21.3	23.4	14.9	8.5	6.3	-	2.1				99.9%
May 25	Nos												5	1	14	7	27
	%												18.5	3.7	51.9	25.9	100%
March 16	Nos					18	22	4	2	3							49
	%					36.7	44.8	8.2	4.1	6.1							99.9%
April 7	Nos					1	31	7	8	1							48
	%					2.1	64.6	14.6	16.7	2.1							100.1%
April 29	Nos					4	14	5	2	1							26
	%					15.4	53.8	19.2	7.7	3.8							99.9%
May 21	Nos														20	19	471
	%														51.3	48.7	100%
	Nos	19	8	26	13	54	141	66	42	26	5	3	7	1	34	36	471
	%	4.04	1.70	5.53	2.76	11.46	29.93	14.0	7.85	5.52	2.12	0.63	1.48	0.21	7.22	5.53	99.99%

Table 4

Relation of length-maturity stage in Boops boops

Length in cm		I	II		III		IV		V		VI		VII		VIII			
		F + M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	M+F	Total
11-11.9	No.	3																3
	%	100																100
12-12.9	No.	4	2	2	-	5	5	-	1	-	-	-	1	1	2	-	-	23
	%	17.4	17.4		22.0		22.0		4.3		-	-	8.6		8.6		-	100.3
13-13.9	No.	11	2	6	1	8	10	2	2	-	-	-	4	1	6	4	4	61
	%	18.0	13.1		14.7		19.6		3.3		-	-	8.2		16.4		6.5	99.8
14-14.9	No.	2	-	6	2	9	13	7	7	1	-	-	-	-	1	1	17	66
	%	3.0	9.1		16.6		30.3		12.1		-	-	-	-	3.0		25.7	99.8
15-15.9	No.	-	1	3	1	15	27	12	3	4	-	-	-	-	-	-	17	83
	%	-	4.8		19.3		47.0		8.4		-	-	-	-	-	-	20.5	100
16-16.9	No.	-	-	4	3	7	42	9	5	7	2	-	-	-	-	-	1	80
	%	-	5.0		12.5		63.8		15.0		2.5		-	-	-	-	1.2	100
17-17.9	No.	1	-	2	2	11	21	7	5	3	3	-	-	-	-	-	-	55
	%	1.8	3.6		23.6		51.0		14.5		5.5		-	-	-	-	-	100
18-18.9	No.	-	-	1	2	6	-	-	3	2	1	2	-	-	-	-	-	17
	%	-	5.9		47.0		-	-	29.4		17.6		-	-	-	-	-	99.9
19-19.9	No.	-	-	2	1	3	-	-	-	1	1	-	-	-	-	-	-	8
	%	-	25.0		50.0		-	-	12.5		12.5		-	-	-	-	-	100
20-20.9	No.	-	-	1	-	-	-	-	1	1	-	1	1	-	-	-	-	5
	%	-	20.0		-	-	-	-	40.0		20.0		20.0		-	-	-	100

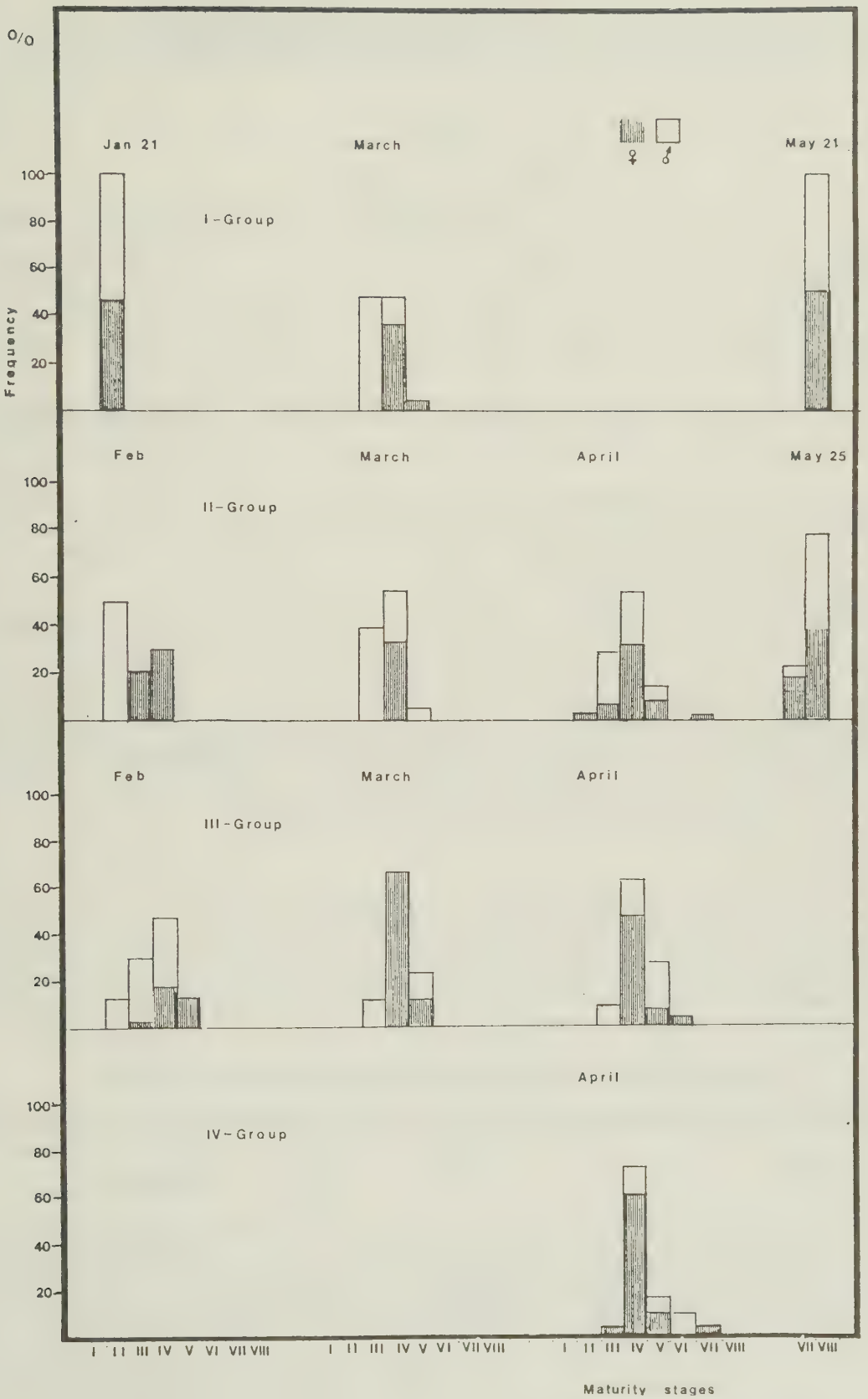

Figure 1 Monthly progress of maturity stages for each age-group

APPENDIX/ANNEXE G

A Study of the Biology and Population Dynamics of Pandora (Pagellus erythrinus L, 1758), Family Sparidae, in the Seas of Cyprus

by

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1. INTRODUCTION

Family Sparidae is the most numerous family in the seas of Cyprus, represented by 10 genera with 17 species. Most of these species are very significant commercially for the fishing industry of the island, especially for the inshore fishery.

Only three species, namely Pagellus erythrinus L, Boops boops L, and Pagellus acarne (Risso) are caught by the trawl fishery during the 7-month trawl fishing season, from November to May, while 14 species are landed by the inshore fishery in various quantities throughout the year.

In the trawl fishery, P. erythrinus represents an annual average of 2.2% in a total catch of 1 917 tons over the period 1981-85 and an annual average of 1.15% in the inshore fishery in a total catch of 5 994 tons during the same period. It rates 6th quantitatively in the catch of the trawl fishery and 18th in the catch of the inshore fishery. The average annual percentage in the whole catch (trawl and inshore) of P. erythrinus is 1.4%.

The bibliography on P. erythrinus L in the Mediterranean is rather limited. Larraneta (1964) has studied the sexual maturity, fecundity, sexual inversion and geographical distribution of P. erythrinus of the coasts of Castellon, and in another study (Larraneta, 1965) the relation between the growth and sexual inversion of the species. He also deals with the growth of P. erythrinus of the coasts of Castellon (Larraneta, 1967). Rijavec and Zupanovic (1965) examine the growth, sexual dimorphism mortality and nutrition of P. erythrinus in the Middle Adriatic. Zei and Zupanovic (1961) deal with the sexual cycle and sex reversal in P. erythrinus. Vassilopoulou et al. (1986) studied the growth and mortality of the species in the Greek seas. Andaloro and Giarritta (1985) studied the growth of P. erythrinus in the Sicilian channel, and Jukic and Piccinetti (1981) examined some aspects of the growth in the Adriatic.

2. MATERIALS AND METHODS

The procedures described in the paper in this volume by the same author on M. barbatus were followed with the exceptions indicated. A total number of 11 420 fish were measured for length frequency distribution during the years 1965-85 on board commercial trawlers, during fishing operations and on the research-fishing vessel "Triton" of the Fisheries Department, during fishing surveys. Out of these fish, a lot of 232 specimens, collected at various occasions between February 1985 and May 1986 were transferred to the laboratory of the Fisheries Department for population characteristics analysis. Details of the samples are shown below:

Details of samples of Pagellus erythrinus for population analysis

Sample No.	Area	Date	Number of specimens	Fishing gear
1	Larnaca Bay	15.02.1985	28	Trawlnet 32 mm
2	Larnaca Bay	19.04.1985	56	Trawlnet 32 mm
3	Episkopi Bay	05.05.1985	40	Trawlnet 32 mm
4	Larnaca Bay	22.02.186	36	Trawlnet 32 mm
5	Larnaca Bay	06.04.1986	29	Trawlnet 32 mm
6	Larnaca Bay	14.05.1986	43	Trawlnet 32 mm

Overall length measured is the total length (LT), from the tip of the lower jaw to the tip of the lower caudal fin, both lobes partially drawn together so that their outer edges are parallel to each other and to the axis. For length frequency distribution, half of class interval, i.e., 0.5 cm, was added to the mean length (L).

2.1 Weight Measurements

Weight of fish was measured on a Mettler P600 Electronic Precision Top Loading Balance with 0.01 g precision.

2.2 Examination of Gonads and Determination of Maturity Stages

For the determination of maturity stages of P. erythrinus, fresh gonads from each fish were first weighed on the Mettler balance with 0.01 g precision. They were then examined under a stereomicroscope for maturity stage determination, according to the classification scale by Kesteven (1960), as follows:

Stage I	Virgin
Stage II	Maturing virgin and recovering spent
Stage III	Developing
Stage IV	Developed
Stage V	Gravid
Stage VI	Spawning
Stage VII	Spent
Stage VIII	Resting

2.3 Age Determination

Determination of age was done exclusively from otolith readings. Scale readings were impossible as almost no year-rings were present. From 153 pairs of otoliths examined, 116 were clearly readable, while 37 were doubtful.

2.4 Age Designation

Age designation in P. erythrinus is similar to that of the other species studied (M. barbatus, B. boops, M. surmuletus), i.e., the first annulus of the new-born fish starts its formation on the fringe of the otolith in February of the year following its birth, i.e., on the 9th/10th month of its first year of life. The annulus is almost completed by April and fully completed by the end of May, i.e., the 12th month. Thus P. erythrinus up to its 9th/10th month is considered to belong to the 0-group. From the 10th month up to the 21st month, when the second year-ring starts its formation on the fringe of the otolith it is considered to belong to age-group I and so on, according to the table below:

Age-groups	0	I	II	III	IV
Months old	0-9/10	10-21	22-33	34-45	46-57
Year-rings	0	1	2	3	4

Designation of age by Chugunova (1959) is in agreement with the above designation. Williams and Bedford (1973) also consider the fish of 0-9 months as belonging in the 0-group, of 10-22 months in the I-group, of 22-34 months in the II-group and so on.

3. RESULTS AND DISCUSSION

3.1 Length-weight Relation

Mean weights for each 1 cm length of P. erythrinus for each sex separately, as well as the range of weights and number of specimens from each length are given in Table 1. Table 2 gives the mean weights at each 1 cm length for sexes combined, the range of weights and number of specimens.

The relation of length-weight of P. erythrinus is:

M + F $W = 2.355 \times 10^{-2} \times L^{2.818}$
$r = 0.99$

M $W = 4.4874 \times 10^{-2} \times L^{2.593}$

$r = 0.99$

F $W = 4.1975 \times 10^{-2} \times L^{2.623}$
$r = 0.99$

Parameters a and b and correlation coefficient r were estimated by the "least squares" method. Another way of expressing the relation of length and weight is to define the condition factor (c.f.) by the use of equation:

$c.f. = W.100/L^3$

M + F = c.f. = 2.351

Length-weight relation parameters of P. erythrinus in the Mediterranean, obtained by other workers are given below:

Andaloro and Giarritta : $W = 0.2474 \times L^{2.9556}$
(Sicilian channel)

Vassilopoulou et al.: $W = 2.7 \times 10^{-5} \times L^{2.930}$
$r = 0.97$
(for Saronikos)

$W = 2.57 \times 10^{-5} \times L^{2.929}$
$r = 0.92$
(for Ionian Sea)

Rijavec and Zupanovic: $W = 0.134 \times L^{2.981}$
(Adriatic)

Passelaigue: $W = 12.4 \times 10^{-6} \times L^{3.16}$
(Marseille)

Girardin: $W = 1.4 \times 10^{-2} \times L^{3.1165}$
$W = 1.32 \times 10^{-2} \times L^{3.1142}$
(Golfe de Lion)

Charbel: $W = 2.4 \times 10^{-2} \times L^{3.0}$
(Tunisia)

3.2 Growth by Length and Weight

(a) Growth in Length

Table 3 gives the mean lengths at each age-group, the range of lengths and number of specimens examined from each age-group, for sexes combined and for sexes separate.

The growth curves of male and female P. erythrinus in Figure 1 exhibit a differential growth in the two sexes from age I upwards, the male fish growing at a faster rate than the female fish and reaching to bigger lengths than the female of the same age.

(b) von Bertalanffy Growth Formula (VBGF)

The three parameters of VBGF L_{oo}, K and t_o were estimated from the equations:

$$L_{oo} = \frac{a}{1-b} \qquad K = -\log_e b$$

$$t_o = t + \frac{1}{K} \log_e \frac{L_{oo} - l_t}{L_{oo}}$$

The two parameters a and b were obtained by the method of "least squares".

The three parameters of VBGF of P. erythrinus thus obtained are:

M + F $L_{oo} = 30.0$ cm, $K = 0.203$, $t_o = -1.623$

M $L_{oo} = 23,45$ cm, $K = 0.457$, $t_o = -0.843$

F $L_{oo} = 27.37$ cm, $K = 0.197$, $t_o = -2.452$

Substituting the three parameters L_{oo}, K, t_o for M + F in von Bertalanffy's equation with the values L_{oo} = 30.0 cm, K = 0.203 and t_o = -1.623 we obtain the growth function for P. erythrinus up to maximum length, L_{max} = 28.5 cm ($L_{max} = L_{oo} \times 0.95$).

Maximum Age. It has been observed, that generally in nature, the oldest fishes of a stock grow to reach about 0.95 of their asymptotic length (Beverton, 1963). Thus from von Bertalanffy's equation we get:

$$t_{max} = \frac{3}{K} + t_o$$

M + F t_{max} = 13.1 years

(c) Growth by Weight

Mean weights at each age of P. erythrinus for sexes combined and sexes separate are given in Table 4 and for sexes separately in Figure 2. It can be observed from Figure 2 that the weight of the male fish is higher than that of the female fish of the same age.

The values obtained for W_{oo}, the asymptotic weight for P. erythrinus are the following:

W : M + F = 342 g
F = 160 g
M = 247 g

Parameters of von Bertalanffy's obtained by other authors for P. erythrinus in the Mediterranean are the following:

Andaloro and Giarritta (Sicilian channel) M + F L_{oo} = 36.7 cm
K^{oo} = 0.1639
t_o = -1.24

Larraneta (Spain) M + F L_{oo} = 51.7 cm
K^{oo} = 0.136
t_o = -1.12
W^{o} = 1 707 g
t^{oo}_{max} = 20.9 years

Rijavec and Zupanovic (Adriatic) L_{oo} = 37.88 cm
K^{oo} = 0.20

Girardin (golfe de Lion) L_{oo} = 30.9 cm
K^{oo} = 0.287
t = -0.654

Gharbel (Tunisia) L_{oo} = 29.0 cm (LST)
K^{oo} = 0.117
t_o = -3.277

Age-length relation of P. erythrinus for the Mediterranean given by other authors:

Author		Age groups 0	I	II	III	IV	V	VI
Larraneta (Spain)	M + F	-	13.4	18.3	22.6	26.3	-	-
Rijavec and Zupanovic (Adriatic)	M + F	-	13.30	15.20	17.49	21.20	24.21	26.70
	M	-	13.20	15.15	17.86	21.02	24.42	-
	F	-	13.40	15.36	17.18	21.15	24.10	-

Author		Age groups 0	I	II	III	IV	V	VI
		Fork length						
Vassilopoulou (Greece)	M + F	-	10.1	12.95	15.34	17.38	18.93	-
Livadas (Cyprus)	M + F	8.4	11.2	16.5	18.2	20.5	-	-
	M	-	13.5	17.4	18.5	21.2	-	-
	F	-	13.5	16.0	18.0	19.7	-	-

3.3 Maturity

(a) Monthly Progress of Maturity Stages-Spawning Time

The process of gonad maturity in P. erythrinus starts in February (15-22), when already the majority of gonads (54%) are in maturity stages II and III. A considerable part (46%) are still in stage I (immature). In April (6-19), gonads are found in all stages of maturity, from II to VI, and a small part of the fish (2.4%) have already started spawning (stage VI), but there is still a considerable part in stage I. In May (5-14), a considerable part of the fish have already completed their spawning (36.2%), some are in the spawning stage VI, and 59% are in stages IV and V. Most probably spawning is completed by the end of May (Table 5).

(b) Body Length-Gonad Weight Relation

The relation of body length-gonad weight in P. erythrinus is given in Table 6, for male and female fish which contains mean weights of male and female gonads, for each 1 cm body length, and the range of gonad weights and number of fish examined. Increase in weight of gonads follows closely length increase in both male and female fish, but the increase in weight of the ovaries is much faster; this is more obvious in April, just before spawning begins.

(c) Mean Monthly Weight of Gonads According to Maturity Stage

Table 7 gives the mean monthly weight of gonads for 1985 and 1986 according to maturity stage, which shows that the weight of gonads increases from February to April each year and decreases again in May, when spawning commences.

(d) Onset of Maturity - Age and Length at First Maturity

P. erythrinus matures in its first year of life (10th month) at a length of about 11 cm. Both sexes mature at the same time. This is shown in Tables 8 and 9.

Age and size of first maturity given by other authors for P. erythrinus in the Mediterranean are as follows:

Larraneta (1964) gives 13.5 cm as minimum size of mature fish; Girardin (1978) estimates corresponding sizes as 14-17 cm and age of maturity as 1-1.5 years. Spawning time was from June to August. Gharbel (1981) for the Gulf of Gabes gives as minimum size for maturity 11.5 cm (LST) for male fish and 11.0 cm (LST) for females. Spawning time was from May to August.

3.4 Length Frequency Distribution of Catch of the Trawl Fishery

Annual length frequency distribution of the catch of the trawl fishery for the years 1965-85 is given in Table 10. There is a decrease in the lengths of P. erythrinus in the catch of trawl fishery from 28 cm in 1966 to 22 cm in 1985. This gradual disappearance of the larger sizes of fish from the catch, is a sure sign of overfishing of the stock.

3.5 Age-Group Composition of the Catch by Year Class, and their Strength

The annual variation in "strength of year-classes" is of fundamental importance for the fishery. It can mean the difference between poor and rich catches in an area and is one of the main causes of yield fluctuations. It is caused by the relative strength of the various year-classes at the time of their recruitment in the fishery. In general, however, the age-group composition is more or less constant over the years and most of the fisheries depend on one or more of the age-groups characteristic for the area.

3.6 Trawl Fishery Catch

P. erythrinus population consists mainly of five age-groups (0-IV) of which only three are of importance to the fishery (I-III) on which this fishery depends, and particularly age groups I and II. However, age-group composition of trawlers' catch until 1971 consisted of 9-10 age-groups (mainly I-X), but the importance of age-groups VI-X was insignificant for the fishery, contributing no more than 2.5% average from 1965-71 (Table 11). Age-group 0 does not appear in the catch but occasionally. Age-group I is not fully recruited to the fishery, while age-group II is fully recruited. Age-groups I-III provide the bulk of the catch for all years, from 1965-85 (80-98% of the catch). The age-group composition of the catch denotes overfishing of the P. erythrinus population.

3.7 Mortality

When studying mortalities of population we are concerned with rates of change, i.e., rate at which the numbers in the population are decreasing, which can be expressed as:

$$\frac{dN}{dt} = -ZN$$

where Z = the instantaneous total mortality coefficient. From this equation the number N_t alive at any time will be given by:

$$N_t = N_o e^{-zt}$$

where N_o is the number of fish alive at time = Q

Another method for obtaining Z is by the method of Beverton and Holt (1956) (from Gulland, 1968). According to this method, when a large number of length frquency data have been obtained from a given stock, by a given gear, Z can be estimated from the mean length ($\bar{L}$) in the catch from a given population by means of:

$$Z = \frac{K\ (L_{oo} - \bar{L})}{\bar{L} - L'}$$

where L_{oo} and K are parameters of VBGF, $\bar{L}$ is the mean length in the catch, and L' is the smallest length of fish fully represented in catch samples. This last method was used for obtaining Z for P. erythrinus, as it gave better results.

3.8 Estimation of Natural Mortality Coefficient

Natural mortality was estimated by the method of Pauly (1983):

$$\log M = -0.0066 - 0.279\ \log L_{oo} + 0.6543\ \log K + 0.463\ \log T$$

where L_{oo}, K are VBGF parameters
T = mean annual bottom temperature of the marine environment

Temperature T was calculated from bottom temperatures of depths from 15-100 meters, taken at 3-month intervals and the value is T = 17.83°C. The value of M thus obtained is M = 0.53. Values of Z, M, F, and E for the trawl fishery for the years 1965-86 are given in Table 11.

3.9 Ratio of Exploitation

Ratio of exploitation $E = \frac{F}{Z}$ gives an indication of whether a stock is overfished or not, on the assumption that the optimal value of E (E_{opt}) is about equal to 0.5.

3.10 Recruitment

Age and length at recruitment. Recruitment is the process in which young fish enter the exploited area and become liable to contact for the first time with the fishing gear:

t_c = mean age at first capture

l_c = mean length at first capture

P. erythrinus is recruited to the trawl fishery at the age of t_c = 6-7 months old and l_c = 8.5-9 cm

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Table 1

Length-weight relation in Pagellus erythrinus L, sexes combined

Length cm	Mean weight gms	Range of weights gms	Numbers
7.0	5.2	5.0 - 5.5	4
8.0	8.5	7.0 - 9.5	7
9.0	11.8	10.0 - 14.0	16
10.0	15.6	14.0 - 18.0	14
11.0	19.7	17.0 - 22.5	22
12.0	25.6	22.0 - 29.0	27
13.0	32.7	29.0 - 37.5	9
14.0	43.1	35.5 - 50.5	15
15.0	51.7	45.0 - 60.0	21
16.0	60.2	53.5 - 69.5	30
17.0	72.4	63.5 - 83.0	22
18.0	83.2	73.0 - 93.0	27
19.0	91.8	85.0 - 99.5	12
20.0	103.5	99.0 - 112.0	4
21.0	120.5	---	1
22.0	137.5	136.0 - 139.0	2

Table 2

Length-weight relation in Pagellus erythrinus L, sexes separate

Length cm	Mean weight gms		Range of weights gms		Numbers	
	M	F	M	F	M	F
11.0	22.5	-	-----	-----	1	-
12.0	26.9	-	26.0- 28.0	-----	5	-
13.0	33.5	34.0	----	32.0- 37.5	1	3
14.0	45.0	43.2	42.0- 48.5	38.0- 47.0	4	7
15.0	54.2	51.7	52.5- 56.5	45.0- 60.0	3	17
16.0	57.8	61.0	55.0- 63.5	53.5- 69.5	7	23
17.0	72.4	72,3	67.5- 77.0	63.5- 83.0	4	18
18.0	80.8	84.9	73.0- 87.5	73.0- 93.0	11	16
19.0	90.7	93.9	85.0- 96.0	90.0- 99.5	8	4
20.0	101.5	105.5	100.0-103.0	99.0-112.0	2	2
21.0	120.5	-	-----	-----	1	-
22.0	137.5	-	136.0-139.0	-----	2	-

Table 3

Age-length relation in Pagellus erythrinus L. Mean length at each age

Age-Groups										
	0		I		II		III		IV	
	M + F		M + F		M + F		M + F		M + F	
Mean length cm	8.4		11.2		16.5		18.2		20.5	
Range of lengths	7.0 - 9.5		9.0-13.5		13.5-18.5		16.5-20.0		19.5-22.0	
Number	12		21		45		31		5	
Increase:			33.3%		47.0%		10.3%		12.6%	
	M	F	M	F	M	F	M	F	M	F
Mean length cm	-	-	13.5	13.5	17.4	16.0	18.5	18.0	21.2	19.7
Number			1	1	10	35	16	15	3	2

Table 4

Age-weight relation in Pagellus erythrinus L. Mean weight at each age

Age-Groups										
	0		I		II		III		IV	
	M + F		M + F		M + F		M + F		M + F	
Mean weight gms	9.0		20.0		62.9		83.5		116.3	
Range of weights	5.0-14.0		10.0-33.5		32.5-93.0		63.5-103.0		95.0-139.5	
Number	12		21		44		31		5	
	M	F	M	F	M	F	M	F	M	F
Mean weight gms	-	-	33.5	32.0	71.2	59.8	84.5	82.3	123.3	105.7
Number	-	-	1	1	9	35	16	15	3	2

Table 5

Monthly progress of maturity stages in Pagellus erythrinus L

FEBRUARY (15-22)												
Maturity stages												
	I	II		III		IV	V	VI	Total
	M+F	M	F	M	F				
N	28	16	6	5	6	-	-	-	61
%	45.9	26.2	9.8	8.2	9.8	-	-	-	99.8%

APRIL (6-19)													
Maturity stages													
	I	II		III		IV		V		VI		Total
	M+F	M	F	M	F	M	F	M	F	M	F	
N	32	4	-	-	2	4	28	-	12	-	2	84
%	38.0	4.8	-	-	2.4	4.8	33.3	-	14.3	-	2.4	100%

MAY (5-14)										
Maturity stages										
	IV		V		VI		VII		VIII	Total
	M	F	M	F	M	F	M	F	M + F	
N	1	17	12	17	4	-	-	-	29	80
%	1.2	21.2	15.0	21.2	5.0	-	-	-	36.2	99.8%

Table 6

Body length-gonad weight relation in Pagellus erythrinus L

FEBRUARY 1985

Length cm	Mean weight gms		Number		Range of weights gms	
	M	F	M	F	M	F
14	0.19	0.28	2	1	0.12-0.26	-----
15	0.34	0.39	2	2	0.23-0.45	0.25-0.54
16	0.26	1.32	1	1	-----	-----
17	-	-	-	-	-----	-----
18	0.60	0.83	7	3	0.50-0.79	0.62-1.21
19	0.83	1.18	7	3	0.50-1.52	0.83-1.70
20	0.56	1.92	2	1	0.55-0.58	----

APRIL 1985

Length cm	M	F	M	F	M	F
13	0.13	1.00	-	1	----	----
14	1.05	0.87	-	1	----	----
15	-	2.72	-	3	----	1.00 - 3.62
16	-	2.94	-	9	----	1.50 - 3.94
17	-	5.03	-		----	3.65 - 6.62
18	0.83	4.89	1	1	----	----
19	1.35	4.68	1	1	----	----
20	-	5.20	-	1	----	----
21	-	-	-	-	----	----
22	2.45	-	2	-	2.33 - 2.57	----

MAY 1985

Length cm	M	F	M	F	M	F
14	0.25	-	1	-	----	----
15	1.35	1.91	1	3	----	1.21 -2.53
16	1.06	2.31	3	6	0.70 - 1.54	2.04 -2.78
17	0.96	2.86	4	8	0.58 - 1.32	2.00 -4.00
18	1.49	3.54	3	10	1.05 - 2.08	0.27 -5.08

APRIL 1986

Length cm	M	F	M	F	M	F
13	0.13	0.85	1	1	----	----
14	1.05	1.52	1	4	----	0.90 - 1.95
15	-	1.52	-	7	----	0.43 - 2.21
16	0.76	2.13	2	6	0.73 - 0.79	1.65 - 3.05
17	-	2.70	-	5	----	2.00 - 3.48
18	-	2.00	-	1	----	----

MAY 1986

Length cm	M	F	M	F	M	F
11	0.14	-	1	-	----	----
12	0.07	-	5	-	0.05-0.14	----
13	-	0.70	-	1	----	----
14	-	0.68	-	1	----	----
15	-	1.58	-	2	----	1.26 - 1.90
16	0.60	2.19	1	1	----	----
17	-	2.65	-	2	----	2.48 - 2.82

Table 7

Mean monthly weight of gonads according to maturity stage in P. erythrinus

	Maturity stages									
	II		III		IV		V		VI	
	M	F	M	F	M	F	M	F	M	F
FEBRUARY 1985										
Mean wt gms	0.58	0.87	0.95	1.27	-	-	-	-	-	-
Number	11	3	5	6	-	-	-	-	-	-
Range of weights	0.5 -1.02		0.53 -1.92		-	-	-	-	-	-
APRIL 1985										
Mean wt gms	-	-	-	1.00	1.77	2.41	-	3.63	-	4.85
Number	-	-	-	1	4	5	-	12	-	2
Range of weights	--		--		0.83-3.62		0.87-6.62		4.82-4.89	
MAY 1985										
Mean wt gms	-	-	-	-	-	2.25	1.00	3.31	2.08	-
Number	-	-	-	-	-	11	11	16	1	-
Range of weights	--		--		0.27-3.9		0.25-5.08		--	
FEBRUARY 1986										
Mean wt gms	0.26	0.35	-	-	-	-	-	-	-	-
Number	5	3	-	-	-	-	-	-	-	-
Range wts	0.12 -0.54		--		--		--		--	
APRIL 1986										
Mean wt gms	0.67	-	-	2.19	-	1.9	-	-	-	-
Number	4	-	-	1	-	23				
Range wts	0.13-1.05		--		0.43-3.48					
MAY 1986										
Mean wt gms	-	-	-	-	0.60	1.72	0.08	-	0.09	
Number	-	-	-	-	1	7	1	-	3	-
Range wts	-	-	-	-	0.68-2.82		--		0.07-0.14	

Table 8

Age-maturity stage relation in P. erythrinus. Age at first maturity

Maturity stages	Age-groups										
	0		1		2		3		4		
	M	F	M	F	M	F					
II	-	-	1	-	10	4	7	1	-	-	N
	-	-	3.12	-	15.87	6.35	20.59	2.94	-	-	%
III	-	-	-	-	3	5	2	2	-	-	N
	-	-	-	-	4.76	7.93	5.88	5.88	-	-	%
IV	-	-	-	2	1	24	1	7	3	-	N
	-	-	-	6.25	1.58	38.10	2.94	20.59	60.0	-	%
V	-	-	1	-	2	11	6	6	-	2	N
	-	-	3.12	-	3.17	17.46	17.65	17.65	-	40.0	%
VI	-	-	3	-	-	-	-	2	-	-	N
	-	-	9.37	-	-	-	-	5.88	-	-	%
VII	-	-	-	-	-	-	-	-	-	-	N
	-	-	-	-	-	-	-	-	-	-	%
VIII	-	-	25		3		-		-		N
	-	-	78.12		4.76		-		-		%
Total	-	-	32		63		34		5		N
	-	-	99.98		99.98		100.0		100.0		%

Table 9

Length - Maturity stage relation in P. erythrinus. Length at first maturity

Length cm		Maturity stages II M	II F	III M	III F	IV M	IV F	V M	V F	VI M	VI F	Total
11	N	-	-	-	-	-	-	-	-	1	-	1
	%	-	-	-	-	-	-	-	-	100.0	-	100.0
12	N	-	-	-	-	-	-	1	-	2	-	3
	%	-	-	-	-	-	-	33.33	-	66.66	-	99.99
13	N	1	-	-	1	-	2	-	-	-	-	4
	%	25.0	-	-	25.0	-	50.0	-	-	-	-	100.0
14	N	3	1	-	-	-	6	1	1	-	-	12
	%	25.0	8.3	-	-	-	50.0	8.3	8.3	-	-	99.9
15	N	2	2	-	-	-	13	1	3	-	-	21
	%	9.5	9.5	-	-	-	62.0	4.7	14.3	-	-	100.0
16	N	3	-	-	1	1	14	3	8	-	-	30
	%	10.0	-	-	3.3	3.3	46.7	10.0	26.6	-	-	99.9
17	N	-	-	-	1	-	10	3	7	-	1	22
	%	-	-	-	4.5	-	45.4	13.6	31.8	-	4.5	99.8
18	N	5	2	2	2	1	3	2	8	1	1	27
	%	18.5	7.4	7.4	7.4	3.7	11.1	7.4	29.6	3.7	3.7	99.9
19	N	4	1	3	2	1	-	1	-	1	-	13
	%	30.7	7.7	23.1	15.4	7.7	-	7.7	-	7.7	-	100.0
20	N	2	-	-	1	-	-	-	1	-	-	4
	%	50.0	-	-	25.0	-	-	-	25.0	-	-	100.0
21	N	-	-	-	-	-	-	-	-	-	-	-
	%	-	-	-	-	-	-	-	-	-	-	-
22	N	-	-	-	-	2	-	-	-	-	-	2
	%	-	-	-	-	100	-	-	-	-	-	100.0

Table 10

Length frequency distribution of the catch of the trawl fishery of P. erythrinus, for the years 1965-85

Length cm	1965		1966		1967		1968	
	N	%	N	%	N	%	N	%
3	-	-	-	-	1	0.09		
4	-	-	-	-	3	0.28		
5	-	-	1	0.18	7	0.65		
6	1	0.33	2	0.36	1	0.09		
7	2	0.66	1	0.18	2	0.18		
8	5	1.65	18	3.26	6	0.56	1	0.39
9	10	3.30	50	9.07	9	0.84	4	1.55
10	31	10.23	53	9.62	41	3.82	10	3.90
11	19	6.27	41	7.44	80	7.46	23	8.95
12	5	1.65	24	4.35	134	12.50	27	10.50
13	3	0.99	39	7.08	180	16.80	42	16.34
14	7	2.31	50	9.07	182	16.98	34	13.23
15	54	17.82	57	10.34	114	10.63	27	10.50
16	87	28.71	55	9.81	113	10.54	27	10.50
17	41	13.53	43	7.80	65	6.06	21	8.17
18	16	5.28	33	5.98	57	5.32	17	6.61
19	11	3.63	28	5.08	13	1.21	6	2.33
20	6	1.98	17	3.08	17	1.58	6	2.33
21	3	0.99	11	1.99	14	1.30	3	1.16
22	1	0.33	8	1.45	11	1.02	3	1.16
23	1	0.33	11	1.99	7	0.65	3	1.16
24			3	0.54	1	0.09	3	1.16
25			3	0.54	12	1.12		
26			1	0.18	1	0.09		
27			1	0.18	1	0.09		
28			1	0.18				
Total	303	99.99	551	99.93	1072	99.95	257	99.94
Mean length	15.32 ± .177		14.86 ± .172		14.76 ± .095		15.08 ± .191	

Table 10 (cont'd)

Length cm	1969		1970		1971		1972	
	N	%	N	%	N	%	N	%
5			8	0.21	1	0.05		
6			31	0.83	3	0.17		
7	5	0.72	88	2.35	9	0.50		
8	3	0.43	96	2.57	43	2.41		
9	18	2.58	109	2.91	141	7.91		
10	41	5.89	178	4.76	153	8.58		
11	43	6.18	207	5.53	153	8.58	4	1.80
12	55	7.90	271	7.25	157	8.81	21	9.42
13	47	6.75	521	13.94	151	8.47	31	13.90
14	55	7.90	766	20.49	129	7.24	39	17.49
15	92	13.22	554	14.82	119	6.67	61	27.35
16	95	13.65	329	8.80	156	8.75	40	17.93
17	72	10.34	212	5.67	193	10.83	17	7.62
18	51	7.33	133	3.56	176	9.87	4	1.79
19	41	5.90	97	2.59	84	4.71	1	0.45
20	26	3.73	50	1.34	47	2.64	1	0.45
21	19	2.73	31	0.83	23	1.29	1	0.45
22	14	2.01	32	0.85	12	0.67	3	1.34
23	5	0.72	14	0.37	15	0.84		
24	8	1.15	5	0.13	11	0.61		
25	6	0.86	6	0.16	5	0.28		
26					1	0.05		
Total	696	99.90	3738	99.96	1782	99.93	223	99.99
Mean length	15.8 ± .133		14.34 ± 0.05		14.72 ± 0.087		15.24 ± .124	

Length cm	1973		1980		1982		1985	
	N	%	N	%	N	%	N	%
7							3	2.07
8	2	0.44	4	1.80			7	4.83
9	6	1.34	3	1.34			11	7.58
10	8	1.78	3	1.34			11	7.58
11	4	0.89	10	4.48	1	1.13	21	14.48
12	26	5.80	50	22.42	1	1.13	25	17.24
13	66	14.73	34	15.24	2	2.27	12	8.27
14	95	21.20	67	30.04	12	13.63	3	2.07
15	102	22.77	25	11.21	31	35.23	5	3.45
16	68	15.18	13	5.83	20	22.73	12	8.27
17	38	8.48	8	3.58	14	15.91	9	6.20
18	17	3.79	4	1.79	2	2.27	8	5.52
19	7	1.56	2	0.89	1	1.13	9	6.20
20	2	0.44			2	2.27	3	2.07
21	2	0.44			2	2.27	1	0.69
22	5	1.11					5	3.45
Total	448	99.95	223	99.96	88	99.97	145	99.97
Mean length	15.20 ± 0.099		13.99 ± 0.126		16.14 ± 0.177		13.88 ± 0.314	

Table 11

Age-group composition of the catch of the trawl fishery for the years 1965-85

Age group	1965		1966		1967		1968	
	N	%	N	%	N	%	N	%
0	15	4.9	58	10.5	26	2.4	4	1.5
I	60	19.8	155	28.1	366	34.1	86	33.4
II	169	55.8	207	37.5	526	49.0	120	46.7
III	50	16.5	82	14.9	100	9.3	33	12.8
IV	7	2.3	21	3.8	27	2.5	6	2.3
V	1	0.3	8	1.4	5	0.4	2	0.8
VI	1	0.3	11	2.0	7	0.6	3	1.2
VII			3	0.5	1	0.1	3	1.2
VIII			3	0.5	12	1.1		
IX			1	0.2	1	0.1		
X			1	0.2	1	0.1		
XI			-	-				
XII			1	0.2				
Total	303	99.9	551	99.8	1072	99.7	257	99.9

Age Group	1969		1970		1971		1972	
	N	%	N	%	N	%	N	%
0	21	3.0	291	7.7	156	8.7		
I	172	24.7	1009	27.0	594	33.3	43	19.3
II	308	44.2	1988	53.2	613	34.4	160	71.7
III	129	18.5	332	8.9	325	18.2	16	7.2
IV	41	5.9	61	1.6	56	3.1	2	0.9
V	6	0.8	32	0.8	6	0.3	2	0.9
VI	5	0.7	14	0.4	15	0.8		
VII	8	1.1	5	0.1	11	0.6		
VIII	6	0.8	6.	0.1	5	0.3		
IX					1	0.05		
Total	696	99.7	3738	99.8	1782	99.7	223	100.0

Age group	1973		1980		1982		1985	
	N	%	N	%	N	%	N	%
0	6	1.3	6	2.7			18	12.4
I	79	17.6	84	37.6	4	4.5	66	45.5
II	312	69.6	123	55.1	68	77.3	32	22.0
III	42	9.4	10	4.5	13	14.8	20	13.8
IV	7	1.5			3	3.4	7	4.8
V	2	0.4					2	1.4
Total	448	99.8	223	99.9	88	100.0	145	99.9

Table 12

Total mortality (Z), natural mortality (M), fishing mortality (F) and ratio of exploitation (E) of trawl fishery for the years 1965-85

Year	Total mortality Z	Natural mortality M	Fishing mortality F	Ratio of exploitation E	l'
1965	0.69	0.53	0.16	0.23	11 cm
1966	0.80	"	0.27	0.33	11 cm
1967	0.66	"	0.13	0.20	10 cm
1968	0.76	"	0.23	0.30	11 cm
1969	0.72	"	0.19	0.26	11 cm
1970	0.74	"	0.21	0.28	10 cm
1971	0.66	"	0.13	0.20	10 cm
1972	0.92	"	0.39	0.42	12 cm
1973	0.71	"	0.18	0.25	11 cm
1980	1.08	"	0.55	0.51	11 cm
1985	1.13	"	0.60	0.53	11 cm

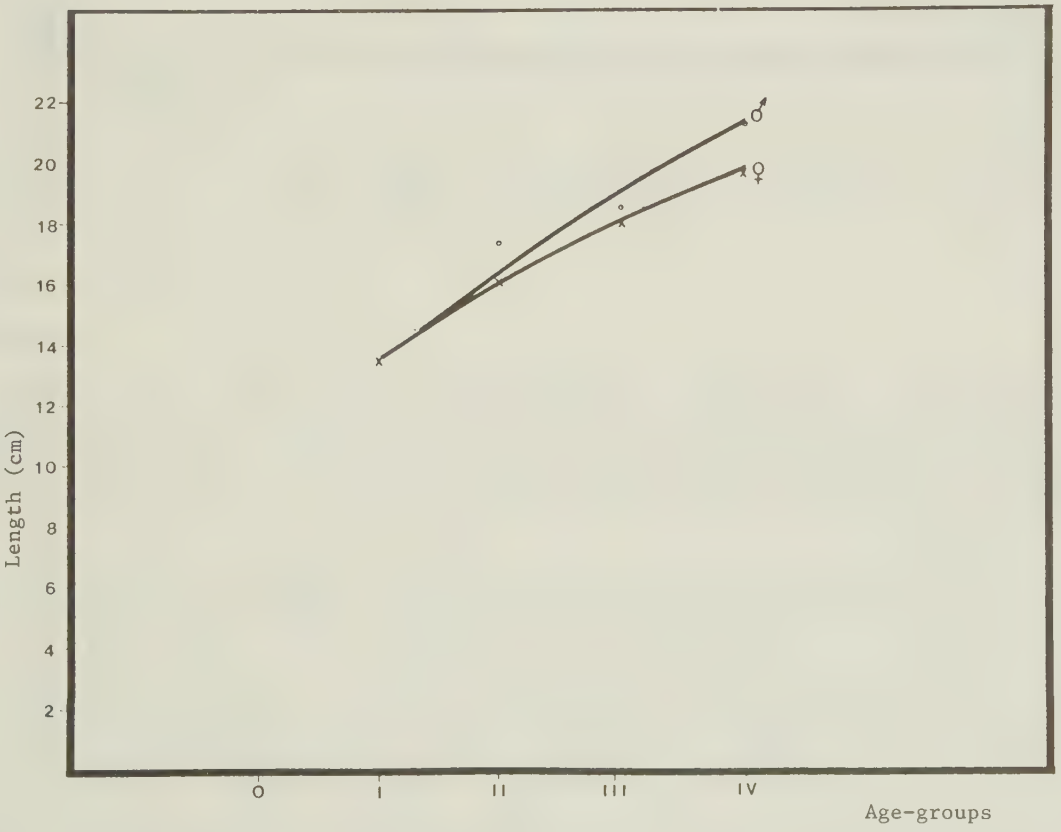

Figure 1 Age-length curve - Sexes separate

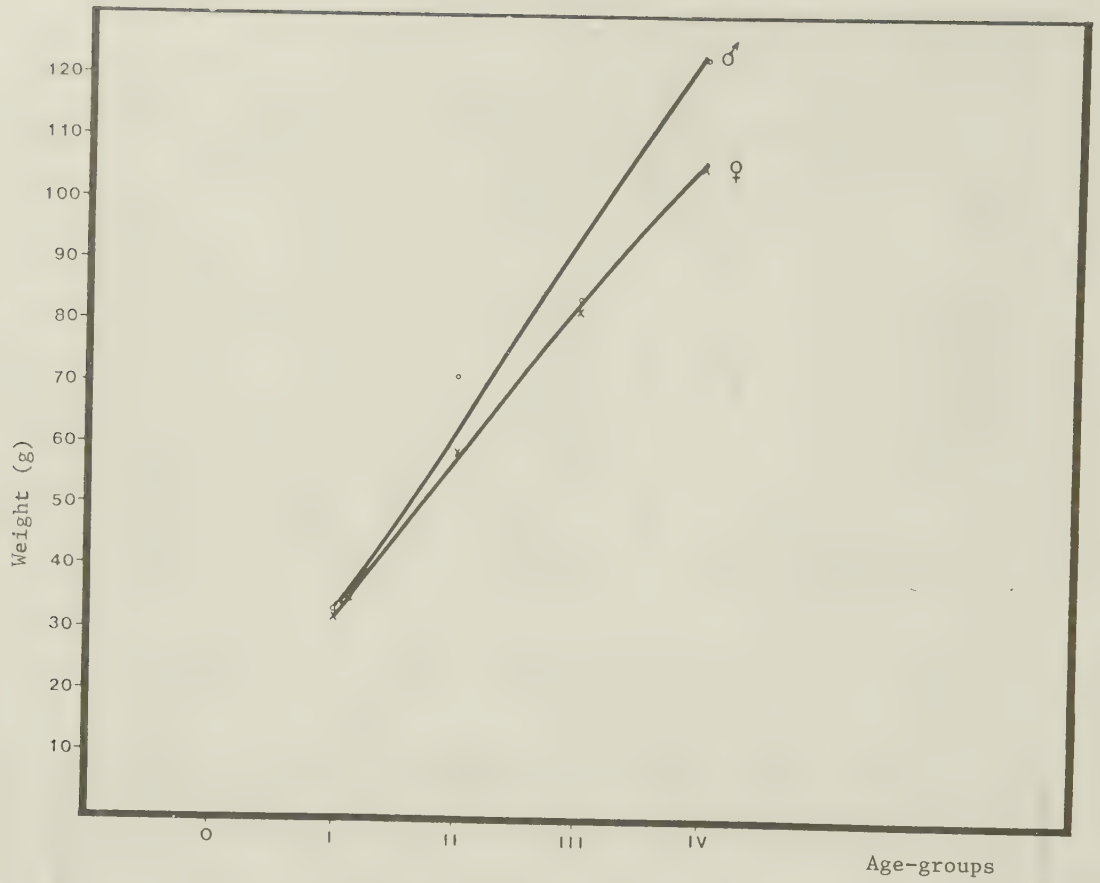

Figure 2 Age-weight curve - Sexes separate

APPENDIX/ANNEXE H

Données biologiques sur le pageot, Pagellus erythrinus, des côtes orientales de la Grèce centrale

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1. INTRODUCTION

Le pageot, Pagellus erythrinus, est un poisson démersal, commun dans les eaux de 15 à 100 m de profondeur. Sa biologie a été étudiée dans les différentes régions de la Méditerranée par plusieurs auteurs (Larraneta, 1967; Mouneimne 1978; Rijavec et Zupanovic, 1965; Hashem et Gassim, 1981; Girardin et Quignard, 1985). Peu d'études ont été publiées sur le pageot des eaux grecques (Papaconstantinou, 1984; Vassilopoulou, Mytilinéou et Papaconstantinou, 1986; Papaconstantinou, Mytilinéou et Panos 1988; Mytilinéou, 1988).

Le pageot présente une grande valeur commerciale en Grèce. Les différents problèmes de sa pêche et le besoin d'un aménagement raisonnable de ses populations rendent nécessaire une meilleure connaissance de sa biologie. Ce travail donne des informations préliminaires sur la distribution, la fréquence de tailles et de l'âge, la croissance, la mortalité, la reproduction ainsi que des éléments sur la dynamique de la population de pageots de la région étudiée.

2. MATERIEL ET METHODES

L'échantillonnage (7 090 individus) a été réalisé par un chalutier commercial, dans le golfe de Petali, les golfes de l'Evoikos (nord et sud), le canal d'Orei et le golfe de Pagassitios, pendant quatre campagnes saisonnières (septembre 1986 - juin 1987). Les stations (figure 1) ont été choisies selon la nature du fond, la profondeur et l'activité halieutique de la région étudiée.

La longueur à la fourche (Lf) en millimètres, le poids total (W) en grammes, les gonades et les otolithes pour la lecture de l'âge, ont été rélevés sur un nombre important d'individus, de toutes les classes de taille. L'étude de l'âge a été fondée sur l'observation microscopique (x 25) des anneaux d'arrêt de croissance; les rayons de l'otholithe et des anneaux ont été mesurés d'après la distance entre le focus et le bord postério-latéral de l'otolithe.

3. RESULTATS ET DISCUSSION

3.1 Abondance

Le pageot, dans la région étudiée, était abondant. Il représentait le 2,5 % du nombre des individus et le 12,3 % du poids, de tous les poissons capturés (figure 2). Ces pourcentages présentaient des variations durant l'année (tableau 1). Pendant les mois de décembre et de mars, les valeurs étaient assez élevées, tandis qu'elles étaient plus faibles pendant septembre et juin. Ces variations étaient peut-être dues aux conditions écologiques et halieutiques de la région et aux habitudes des poissons (migrations pour la reproduction et l'alimentation).

La fréquence de la présence des pageots, dans les cinq zones de la région étudiée, a montré (figure 3) que le plus grand nombre des individus était rencontré dans le canal d'Orei (30,9 %) et le golfe de Pagassitikos (25,4 %); puis dans le sud d'Evoikos (18,4 %) et dans le nord d'Evoikos (16,6 %). Le pourcentage du golfe de Petali était assez bas (8,7 %). On peut supposer que les grands pourcentages d'Orei et de Pagassitikos sont liés à l'interdiction de la pêche au chalut, pendant toute l'année. Dans les golfes de Petali et du nord d'Evoikos, cette pêche est interdite durant une période seulement de 4 et 7 mois respectivement. Le golfe du sud d'Evoikos, zone où la pêche au chalut est interdite pendant toute l'année, donnait l'image d'une région pêchée. Cette image est fort probablement due aux conditions écologiques de la région.

Les pourcentages du poids des pageots, dans chacune des zones de la région étudiée (figure 3), ont indiqué des résultats similaires à ceux cités ci-dessus, pour les pourcentages du nombre des individus. Seul le golfe du nord d'Evoikos présentait un pourcentage du poids élevé d'un petit pourcentage du nombre des individus.

3.2 Distribution

L'échantillonnage effectué dans les différentes stations, a présenté (figure 4) que, pendant toute l'année, la plupart des individus (69 %) vivaient jusqu'à la profondeur de 60 m (stations 1, 4, 5, 10, 11, 12, 13, 14, 21, 22, 23, 25, 29, 31, 34). Le nombre des individus se diminuait progressivement (28 %) aux profondeurs entre 60-100 m (stations 15, 16, 17, 18, 19, 20, 24, 26, 28, 30) et devenait minimal (3 %) aux profondeurs supérieures à 100 m (stations 27, 32). La profondeur maximale où les pageots étaient présents, était celle de 130 m (station 32 - 0,01 %).

La distribution des tailles des pageots était liée à la profondeur; il semblait que les jeunes vivaient près de la côte, tandis que la taille des adultes grandissait successivement, en s'éloignant de la côte pour les eaux profondes.

3.3 Distribution de fréquence en fonction de la taille et de l'âge

La distribution des fréquences en fonction de la taille et de l'âge, pour l'ensemble des individus capturés (figures 5a et 5b), a présenté que la plupart des individus (64 %) avaient une longueur à la fourche entre 10,0-17,5 cm et appartenaient à trois groupes d'âge (groupe d'âge I avec un mode dans 11,5-13,0 cm, groupe II avec un mode dans 14,5-16,0 cm, groupe III avec un mode dans 16,0-17,5 cm). Les individus des tailles supérieures, de 19,0 à 43,0 cm de longueur (groupes d'âge IV-XI), présentaient un pourcentage de 26 %, tandis que les individus des tailles inférieures, de 4,0-8,5 cm (classe d'âge 0+), présentait un pourcentage de 10 %. Le pourcentage de jeunes individus était sous-estimé, à cause de l'impossibilité du chalutier, de pêcher près de la côte; celui des individus âgés, semblerait avoir été lié à la mortalité naturelle et à la mortalité par pêche.

La taille minimale des individus était 4,2 cm et la maximale 43,0 cm. L'étude de l'âge a indiqué onze groupes d'âge (0+ - XI); l'âge des quelques individus de grande taille n'a pas pu être déterminé.

3.4 Croissance

Les longueurs moyennes de chaque groupe d'âge ont été calculées d'après la méthode de rétrocalcul (tableau 2). Le plus grand pourcentage de la croissance avait lieu jusqu'à l'âge I.

Le modèle de von Bertalanffy a été aussi utilisé, pour décrire la croissance du pageot. Les paramètres de croissance, obtenus par la méthode Ford-Walford étaient:

$L_{oo} = 48,2$ cm, $k = 0,062$

La très basse valeur du coefficient k peut être expliquée par la structure de l'échantillon et la présence considérable des individus de grande taille qui provoque des variations au coefficient k. En effet, si les individus de grandes classes d'âge étaient éliminés de l'échantillon utilisé, la valeur de k augmenterait (pour les groupes d'âge 0-VI: k = 0,156).

Ces résultats peuvent difficilement être comparés à ceux d'autres auteurs, parce que certains utilisent la longueur totale ou standard et certains les écailles pour la détérmination de l'âge. Malgré ces différences, nous pouvons dire que le pageot de la région étudiée présentait une croissance assez lente. Les résultats de ce travail sont plus proches à ceux de Rijavec and Zupanovic (1965) pour le pageot de la Moyenne Adriatique, de Vassilopoulou, Mytilinéou et Papaconstantinou (1986) pour le pageot du golfe de Saronikos et de Papaconstantinou, Mytilinéou et Panos (1988) pour le pageot des côtes occidentales de la Grèce.

3.5 Relation taille-poids

La relation taille-poids a été calculée pour l'ensemble des individus (sur 1 218 pageots) et pour chacun des sexes (sur 146 mâles et 768 femelles). Les résultats obtenus étaient:

Total: $W = 0,0000151\ L^{3,044}$, $r = 0,98$

Mâles: $W = 0,0000116\ L^{3,096}$, $r = 0,99$

Femelles: $W = 0,0000135\ L^{3,069}$, $r = 0,99$

où W: le poids total en grammes, L: la longueur à la fourche en millimètres et r: le coefficient de corrélation.

3.6 Mortalité

La mortalité totale (Z), estimée par les paramètres de croissance, a été calculée d'après Pauly (1983): $Z = 0,4$. La mortalité naturelle (M) a été obtenue, en utilisant l'équation de Pauly (1983): $M = 0,18$. Les deux valeurs Z et M, mentionnées ci-dessus, ont été utilisées pour estimer la mortalité par pêche: $F = 0,22$.

Selon la formule E = F (F + M), le coefficient de l'exploitation (E) était E = 0,55. La valeur du coefficient E, très proche à la valeur optimale (E = 0,5), peut être expliquée par l'existence des zones interdites à la pêche au chalut, pendant toute l'année, d'où la présence des individus de grande taille dans nos échantillons. Au contraire, les valeurs des coefficients d'exploitation du pageot des côtes orientales de la Grèce (Papaconstantinou, Mytilinéou et Panos, 1988) et du golfe de Saronikos (Vassilopoulou, Mytilinéou et Papaconstantinou, 1986), régions surpêchées, étaient très élevées (E = 0,87 et E = 0,76 respectivement).

3.7 Cycle sexuel

L'étude des différents stades de maturation des gonades a indiqué que le pageot, dans la région étudiée, se reproduisait principalement pendant l'été. La période de reproduction se terminait en septembre. La taille de première maturité a été trouvée dans la classe 16,5-18,0 cm pour les femelles et dans la classe 22,5-24,0 cm pour les mâles.

Le sex ratio des mâles par rapport aux femelles, a montré que le pourcentage des mâles était 16 % et celui des femelles 84 %, d'où le rapport 1:5,3. Les femelles présentaient une prédominance dans les petites tailles, et les mâles dans les grandes tailles, phénomème lié à l'existence d'un hermaphroditisme protérogyne.

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Tableau 1

Variations saisonnières des pourcentages du nombre des individus et du poids, par rapport à l'ensemble de tous les poissons capturés, dans la région étudiée

	N	%	W (kg)	%
Septembre	1 422	1,4	151,026	8,9
Décembre	2 345	3,2	246,904	14,7
Mars	1 866	3,1	166,460	12,1
Juin	1 511	2,8	152,600	14,2

Tableau 2

Longueurs moyennes (mm) de chaque groupe d'âge du pageot de la région étudiée, calculées d'après la méthode de rétrocalcul

Groupes d'âge	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Longueur moyenne	117,4	149,7	169,6	187,0	201,9	215,6	228,9	240,2	251,1	258,6	265,5
Numéro des individus	484	334	228	136	83	47	31	15	10	3	1

Figure 1 Région de recherche et stations d'échantillonnage

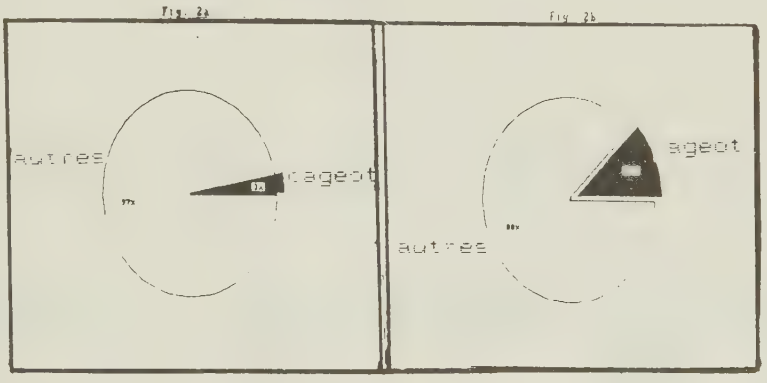

Figure 2 Pourcentages du nombre des individus (a) et du poids (b) du pageot, par rapport à l'ensemble des poissons capturés

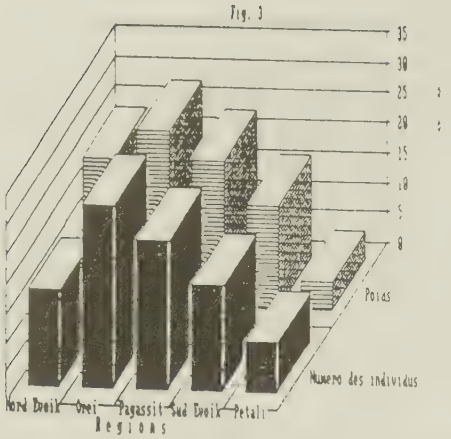

Figure 3 Pourcentages du nombre des individus et du poids du pageot dans les différentes zones de la région étudiée

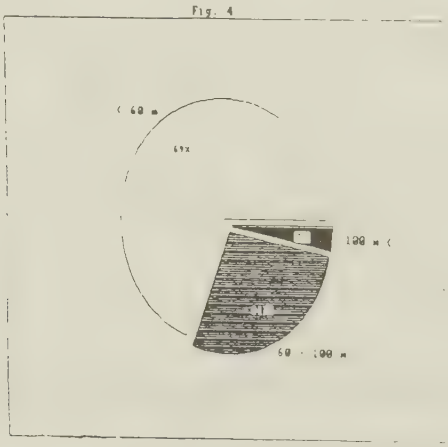

Figure 4 Fréquence de la présence du pageot en fonction de la profondeur, dans la région étudiée

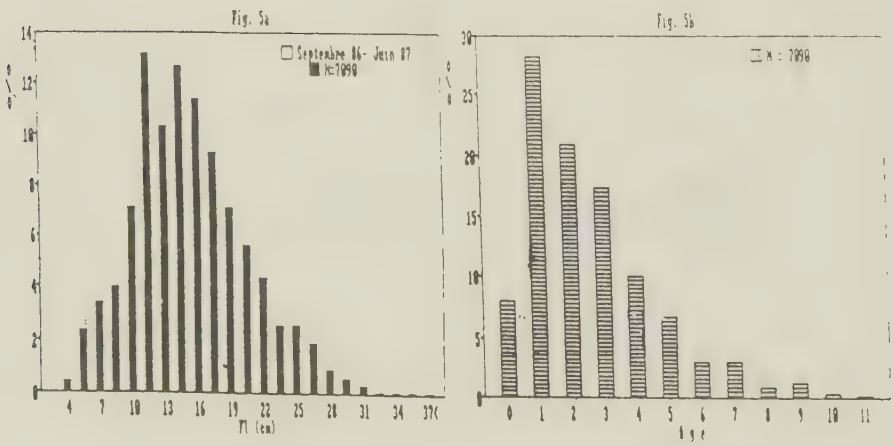

Figure 5 Distribution des fréquences en fonction de la taille (a) et en fonction de l'âge (b) du pageot, dans la région étudiée

APPENDIX/ANNEXE I

Some Data on the Population Dynamics of Blue Whiting (Micromesistius poutassou) in the Northern Euvoikos Gulf

by

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1. INTRODUCTION

The blue whiting Micromesistius poutassou (Risso, 1826) is a small schooling gadoid fish; its geographical distribution extending along the outer continental shelf of western Europe, in the Western North and North Atlantic from the western Barents Sea, Spitzbergen, Iceland, Greenland and Kattegat to Morocco; also it is found in the Mediterranean Sea (Svetovidov, 1986). This is a mesopelagic species, and its bathymetric range extends over depths of 160-3 000 m in midwater.

No information is available on the life history and population dynamics of the blue whiting in the Eastern Mediterranean, where the presence of the species was until recently doubtful (Svedovidov, 1986). Several authors have summarized and discussed the occurrence and life history of blue whiting in the Atlantic Sea (Raitt, 1968a, b) and in the Western Mediterranean (Orsi and Peirano, 1981, et al.). Papaconstantinou, et al. (1988) have studied the migration of the species between Patraikos and Korinthiakos Gulf and its feeding habit.

The objectives of this paper are to provide information on growth, mortality, length/age composition and reproduction of blue whiting which is rather heavily exploited in the Northern Euvoikos Gulf. This information will be useful in managing the rapidly developing fishery for blue whiting in the area.

2. MATERIAL AND METHODS

Between September 1986 and June 1987, seasonal samples of blue whiting totalling 4 509 specimens were obtained in the Northern Euvoikos Gulf (Figure 1) from catches of a commercial trawler, using a 500 hp motorboat; towing a net with a cod-end mesh of 14 mm between stretched knots. Total length (TL) to the nearest millimetre, weight to the nearest gramme, and sex, when possible, were recorded. Otoliths (Sagittae) were removed, wiped clean, and stored in glycerin in plastic vials. Because whole otoliths are thick and opaque, they were mounted, in cold mounting resin and cut transversely through the focus with a Buehler Isomet 11-1180 low-speed saw, to remove thin sections about 0.5 mm thick. The cut was performed by two rotary saws 0.5 mm distance apart. Otoliths sections were subsequently ground and placed on a blackground where the opaque marks were examined in reflected light at 25 X magnification.

Measurements were taken from the focus to the distant edge of each mark, and to the otolith edge along the greatest radius of the otolith. A von Bertalanffy theoretical growth curve was fitted to mean observed lengths by the Ford-Walford plot. Total and natural mortality rate were estimated following Pauly (1983).

Length Frequency Distribution

The seasonal length-frequency distribution over the period September 1986 to June 1987 is illustrated in Figure 2. The total length of 4 452 blue whiting measured ranged from 100 to 310 mm. Length frequencies required careful interpretation because blue whiting have a prolonged spawning season (December to March) and age groups overlap broadly in size.

The length frequency distribution of the first two samples (September and December 1986) suggested that the population consisted mainly of four year classes, with modes at approximately 170, 220, 240 and 260 mm. During both seasons however, it was apparent that there were at least seven years classes with the appearance in the classes of a few very large fish of 270-310 mm. Subsequent examination of the otoliths showed that the longest size group included fish with ages ranging from 5+ to 9+ years.

The sample made in March 1987 shows a dominant mode ranging from 170 to 190/200 mm, representing age group 0 or 1+, hatched in the end of fall or early winter 1986. The fact that the mode 170 mm was in high abundance during this season suggests that the younger fish moved in shallower depth.

Spawning from December to March is followed next June by appearance of new recruits, which in early summer were the dominant size group. Their length was 140 mm. Growth of this year class can be followed all round the year until next March, by which time the mean length had increased to 190/200 mm. The apparent decrease in relative abundance of <I+ group in June may be the result of either the fish being accessible to capture at this time or that they moved out of the area and returned in the fall, or that the shoals disperse and reunite statistically with a student's t-test. As there was no significant difference between the two sexes for the length in a particular age class, growth was determined regardless of sex. It should be noted that those aged 8-9 years represented females only because no males were caught. Growth rate is very fast in the first year, the mean calculated size at 1-year age being just 20 cm; thereafter the annual growth rate decreases progressively reaching 10 mm in the sixth year, after which it remains constant at about 4 mm annually (Table 1).

Table 1

Back-Calculated Lengths (mm) at the End of Each Year of Life by Ages Class Blue Whiting from the Northern Euvoikos Gulf

Age group	Number of fish	Length capture	Mean calculated length at the end of the year									
			0	1	2	3	4	5	6	7	8	9
0	50	164.4	158.3									
1	72	202.2	164.6	194.0								
2	53	233.1	162.1	200.7	225.5							
3	23	248.0	160.6	197.1	224.8	239.2						
4	21	264.4	168.6	201.4	226.3	244.3	257.1					
5	11	270.5	168.8	195.3	222.9	242.0	256.1	266.7				
6	6	277.8	166.4	204.9	224.5	238.7	251.7	262.8	272.6			
7	7	287.4	167.1	199.3	223.7	240.7	255.7	268.3	278.7	286.4		
8	2	299.0	171.6	198.6	222.4	241.4	258.0	268.3	277.0	285.0	292.1	
9	1	315.0	139.9	187.5	206.5	219.2	231.9	244.6	258.8	271.5	282.6	292.1
Grand average length			163.0	197.6	224.9	241.0	255.5	265.6	275.0	284.7	288.9	292.1
Number of the fish			246	196	124	71	48	27	16	10	3	1

The calculated growth of blue whiting in Northern Euvoikos Gulf showed some evidence of the effects of the commercial fishery on the growth history of fish of various age groups. Calculated lengths for each year of life decreased with an increase in age. This effect (Lee's phenomenon) is more pronounced on the otoliths of older fish. This phenomenon may account for the underestimation of lengths for younger age-groups, and has been attributed to various causes. If the population is exploited by a commercial fishery, the discrepancies may originate from gear selectivity, which can cause progressive destruction of the faster growing fish of a year class as it enters and passes through the fishery.

The mean length for successive ages has been taken, for both sexes combined, and the von Bertalanffy growth equation has been fitted to them by "Ford-Walford" plot. The observed mean length for age and the calculated values are very close, demonstrating that this growth equation gives a good fit to the data from age I.

The von Bertalanffy equation was:

$$Lt = 326.7\ (1-e^{-0.247(t + 0.351)})$$

The theoretical maximum length (L_{oo}) = 326.7 mm was close to that of the largest specimens observed 310 mm TL. The t_o = 0.351 estimate was obtained from the empirical relationship:

$$\log (-t_o) = -0.3922 - 0.2752 \log L_{oo} - 1.038 \log K$$

Length and Weight Relationship

The length-weight relation of blue whiting from the Northern Euvoikos Gulf was based on all available fish combined regardless of season of capture, sex and state of maturity. The relationship of weight (W, g) to total length (TL, mm) was described by the equation:

$$W = 2 \times 10^{-6} \times TL^{3.212} \quad r = 0.99$$

There was no significant difference in the regressions between sexes. The value of b = 3.212 (above 3) indicates that blue whiting becomes progressively "plumper" with increase in length.

Mortality

The total mortality rate was estimated by the catch curve following the Pauly (1983) method. The value of the total mortality coefficient was Z = 0.683 for the study area. The natural mortality M was calculated according to Pauly (1983) equation:

$$\log M = -0.0066 - 0.279 \log L_{oo} + 0.6543 \log K + 0.4634 \log T$$

and was estimated M = 0.52

Once the value of M and F are available an exploitation ratio (E) may be computed: E = F/(F + M), which allows one to estimate if a stock is overfished or not. In our case E = 0.24, in fall.

Age Composition of the Samples

Figure 3 shows the percentage age composition of blue whiting sampled during the present investigation in the Northern Euvoikos Gulf from September 1985 to July 1986. Specimens aged from otoliths were 0+ to 9+ years old. The bulk of the samples examined, however, more than 70% fo the total, consisted of fish of less than I year of age. The relative abundance of year classes from season to season follow a clear pattern: the June samples were dominated by the 0 age group (75%); in the following seasons the fish increased steadily in size until next March, when no 0 age group was found. The samples fished in this season contained a much larger proportion of older fish. From the age frequency histograms for blue whiting collected throughout the year, the time of annulus formation in Northern Euvoikos Gulf appears to be in winter, with the peak annulus formation taking place in January and February.

Size and Growth

The best regression fit of the total length on otolith radius by the method of least squares gave the linear regression:

$$TL = 60.7 + 3.17R$$

where TL = total length and R = otólith radius x 25.

Using this relationship, growth was back-calculated for males and females. Females were slightly longer than males at all ages, and observed differences between sexes were tested which is very low, indicating that the blue whiting stock in the Northern Euvoikos Gulf is not heavily exploited.

Reproduction

Information on maturity is available only for the three cruises in 1986-87 (December, March and June) when the maturity of 234 fish was recorded. It should be noted that just after spawning the gonads become extremely small and filiform. The above sample gave the following proportion of the two sexes: male = 106 and females = 128 (1:1.21).

From the seasonal distribution of maturity stages it seems that blue whiting spawn in the Northern Euvoikos Gulf between January and March (Figure 4). Stages I and II (virgin and immature) are classified as immature fish, maturing fish are stages III and IV, mature V and ripe VI. Immature fish ranged from 12 to 28 cm, but it is clear that the virgin fish reach 20 cm, and the mature/ripe fish were all over 1 year old. It is not possible to draw any definite conclusions from these scattered data although it would apper that fish reach first maturity at about 19 cm and upwards, at an age of I+ - II years.

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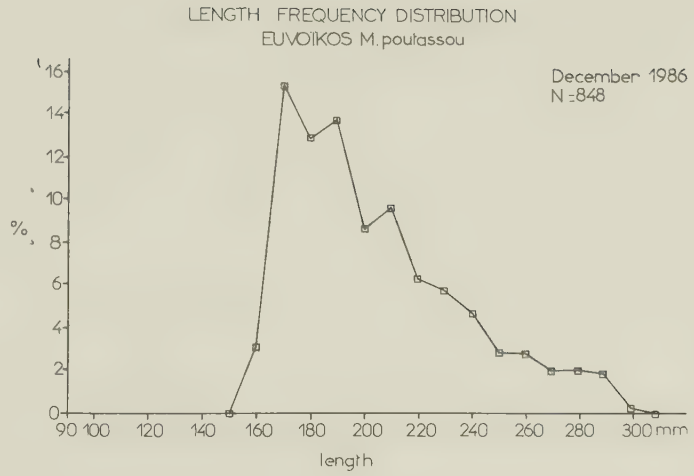
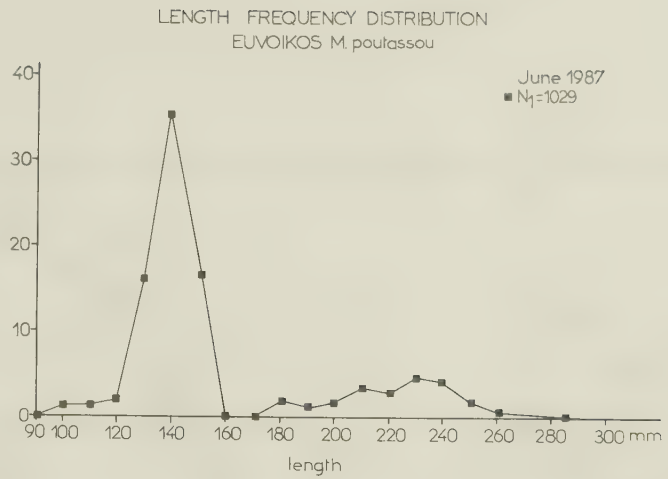
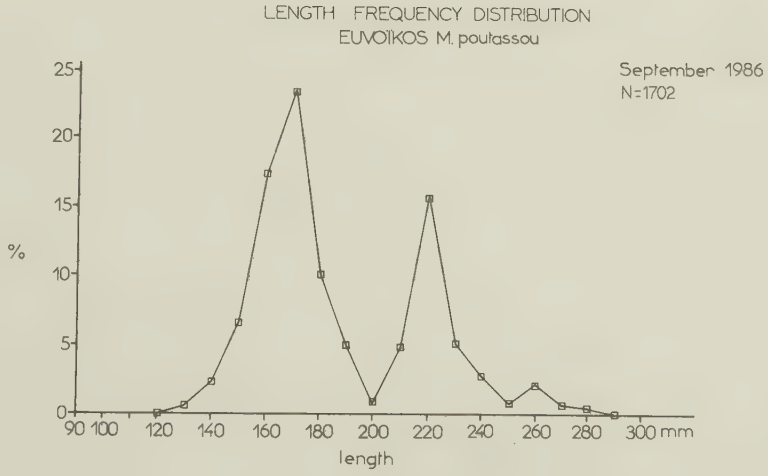
Figure 1 A map of the Northern Euvoikos Gulf with the sampling stations







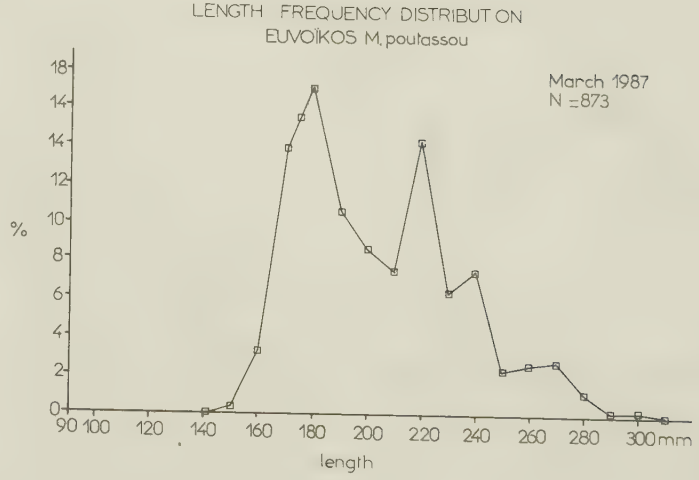


Figure 2 Length frequency distribution of blue whiting during all four seasons of 1986-1987

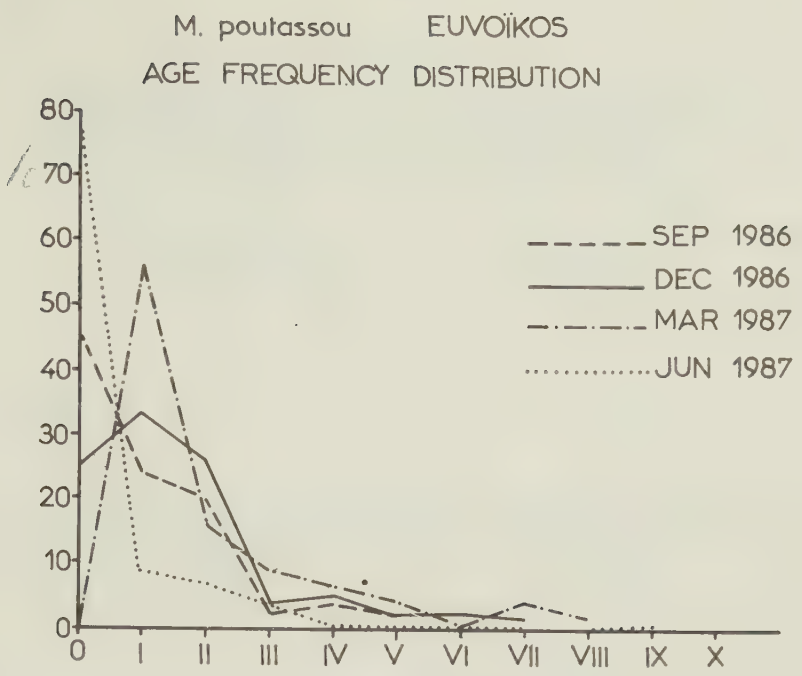


Figure 3 Age frequency distribution of blue whiting during all four seasons of 1986-87

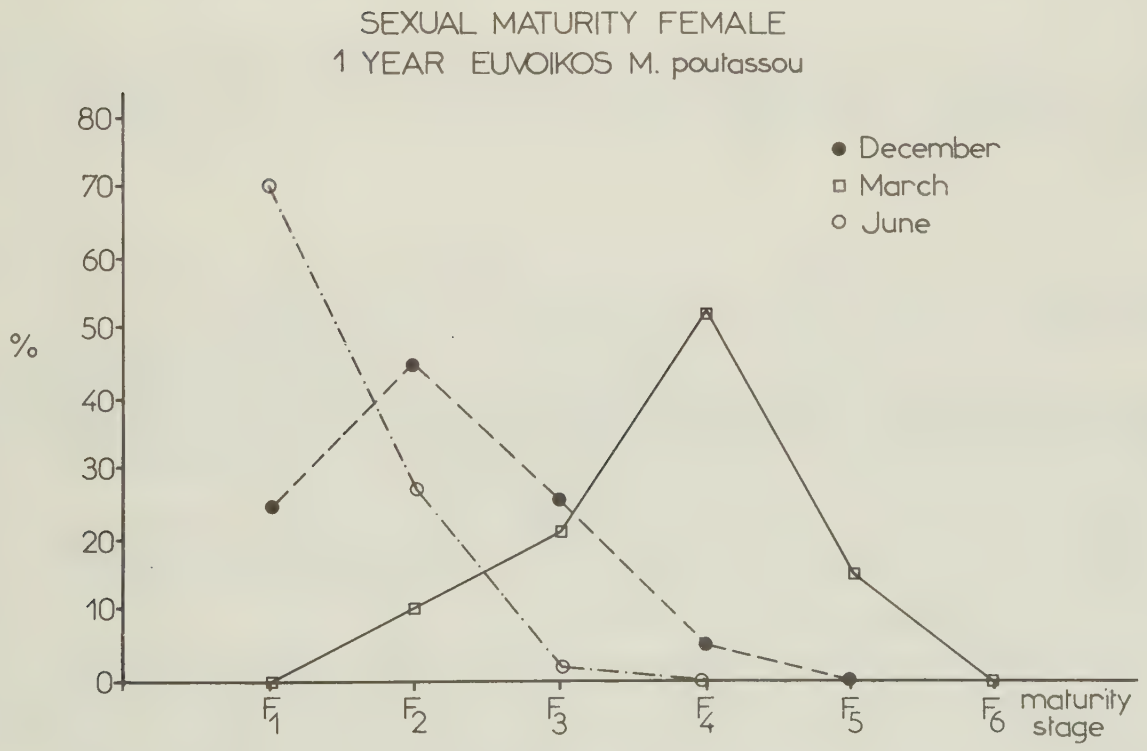


Figure 4 Time of different stages of maturity of blue whiting in the Northern Euvoikos Gulf

APPENDIX/ANNEXE J

Feeding of Poor-Cod (Trisopterus minutus capelanus R.) in the Euboean and Pagassitikos Gulfs (Greece)

by

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1. INTRODUCTION

Even though the poor-cod Trisopterus minutus capelanus is common in the Mediterranean Sea, it has rarely been the subject of biological studies. In the bibliography we mostly find papers referring to the sister subspecies of the Atlantic Ocean Trisopterus minutus minutus (L). Some biological data of T. m. capelanus can be found in Vives and Suau (1956), in CGPM-FAO (1980), in Froglia (1981) and in Tangerini and Arneri (1983). However its feeding has not been studied at all as far as we know.

In this presentation we are going to expose our preliminary results on the feeding of T. m. capelanus of the Euboean and Pagassitikos Gulfs.

2. MATERIAL AND METHODS

The material for this study was collected in December 1986, March 1987 and September 1987 over a grid of 16 stations in the Euboean and Pagassitikos Gulfs by trawling by means of 500 hp trawler (Figure 1).

The individuals that were to be analysed were fixed immediately in a 5% formalin solution. In total 482 specimens of T. m. capelanus have been examined . For each fish fork length and body weight were measured. Stomach content was weighed to the nearest 0.01 g and prey items were identified to species level, wherever possible.

3. RESULTS

a. Total Diet Composition

The numbers and percentages of empty stomachs and stomachs containing food are given in Table 1 and the length frequency distribution of the fish sample is given in Figure 2.

According to our results T. m. capelanus feeds mainly upon crustaceans which contribute 95.2% to the diet by number and 60% by weight (Figures 3 and 4), of these mysids dominate in terms of number (50.3%) but represent only 2.9% by weight. Natantians comprise 18.3% by number and 27.3% by weight. Crabs constitute 4.5% and 12% respectively. Finally, euphausids compose 10.8% by number and 3.1% by weight. Anomura and macrura are less important than other crustaceans. Occasionally some copepods, amphipods and isopods are also found.

Fish rank second in importance in the food of T. m. capelanus and represent 34.1% of the diet by weight and 2.9% by number, polychaetes and molluscs are also found in some stomachs.

b. Diet Composition in Relation to Predator size

In Figure 5 we can observe the fluctuation of prey composition of the 5 main taxa in the diet of T. m. capelanus: Mysidacea, Euphauciacea, Natantia, Brachyura and fish.

Mysids compose the main food in number of the smaller specimens (8-12 cm FL) but their consumption falls abruptly at the length of 12 cm and becomes nil at 21 cm.

The consumption of euphausids diminishes slightly up to 19 cm and then drops to zero. The percentage of natantians rises gradually from less than 10% at 8 cm up to a maximum of more than 40% at 19 cm and it still remains important up to the length of 24 cm. The percentage of Brachyra is almost nil in the smaller individuals and shows a peak at the length of 21 cm (25%).

Table 1

Number of stomachs examined and vacuity coefficient (V)

Number of fish	482
Regurgitated	43
Empty stomachs	42
Stomachs with food	397
% empty stomachs (V)	9.6
Stomachs with food	90.4

Finally fish are consumed by individuals longer than 11 cm. Their consumption rises proportionally with size and reaches a maximum at the length of 23 cm.

The change of diet composition by weight shows a similar pattern (Figure 6) with the exception of natantians that seem to represent an important proportion of the diet by weight in almost all fish sizes. It is remarkable that a switching from mysids and euphaucids to fish occurs at the length of 13 cm.

4. CONCLUSION

In conclusion T. m. capelanus, at small sizes, is mainly a crustacean feeder, while at larger sizes it consumes fish as well. It feeds alternatively on benthic organisms and on animals from near to the bottom of the water column. The general dietary pattern of T. m. capelanus of Euboean and Pagassitikos Gulfs is similar to that reported for T. m. minutus of the Atlantic Ocean (Planas and Vives, 1952; Labarta, 1976).

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Figure 1 Map of sampling area, Euboean and Pagassitikos Gulfs

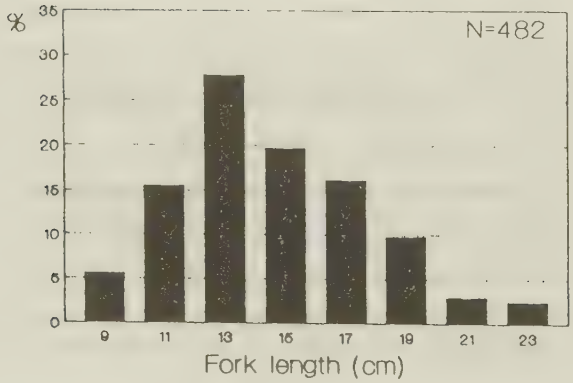
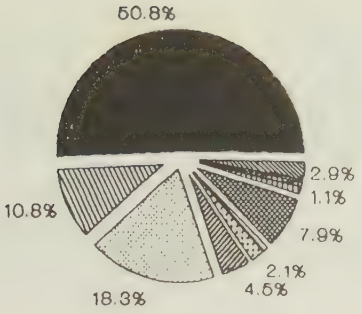
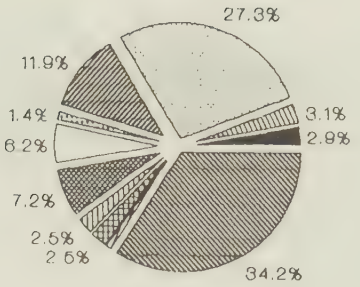


Figure 2 Length frequency distribution





* This group comprises unidentified crustaceans, copepods, amphipods, isopods.

Figure 3 Total diet composition by number (%)

Figure 4 Total diet composition by weight (%)

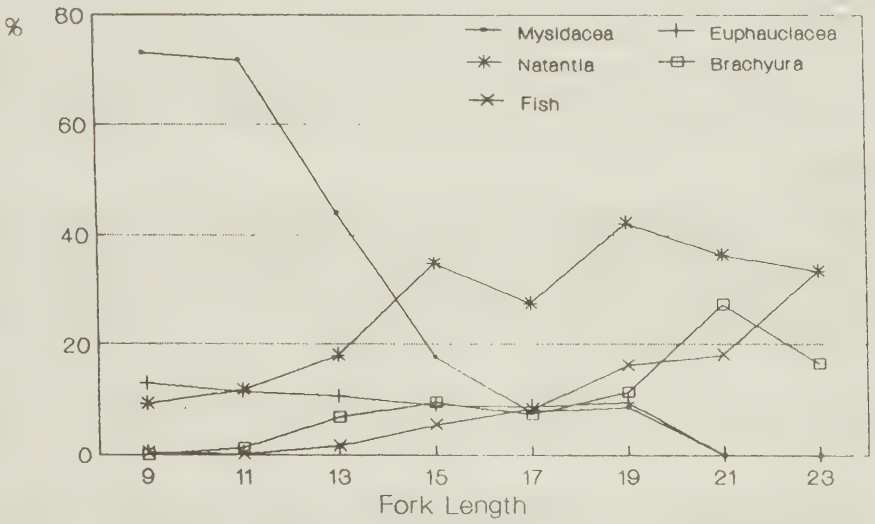


Figure 5 Variation of prey (percentage composition by number) per length group of T. m. capelanus

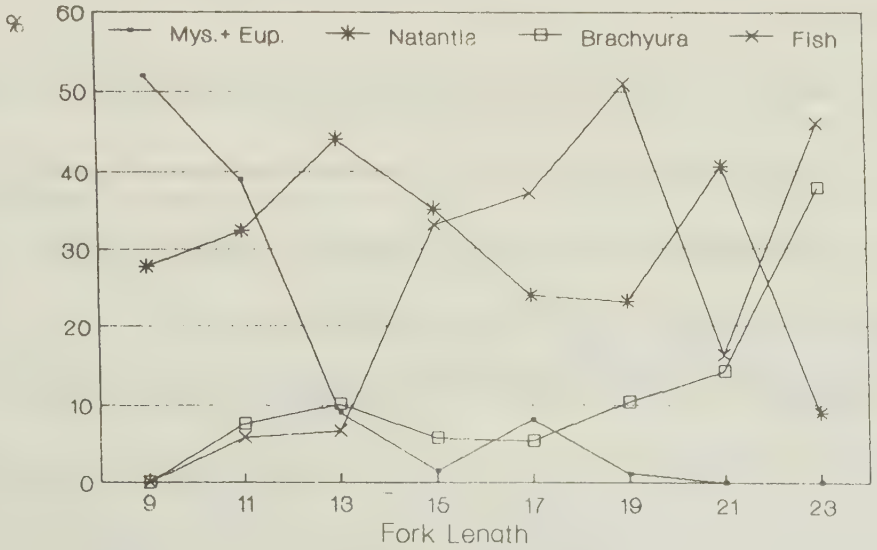


Figure 6 Variation of prey (percentage composition by weight) per length group of T. m. capelanus

APPENDIX/ANNEXE K

Length-based Approach to the Estimation of Growth and Mortality Parameters of Spicara smaris (L.) in the Saronikos Gulf, Greece, and Remarks on the Application of the Beverton and Holt Relative Yield per Recruit Model

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1. INTRODUCTION

Picarel (Spicara smaris, L.) is a common species in the Mediterranean basin found usually in the littoral and sublittoral zones of the sea, at depths ranging from 15 m to 170 m (Salekhova, 1979; Fischer, Bauchot and Schneider, 1987). This species has not yet attracted much attention among scientists involved in fisheries research, however, its significance in Greek waters and commerce cannot be neglected. According to the National Statistical Service of Greece, the total catch of Spicara smaris, caught in the trawl during the 1981-85 years, occupies a distinct position amongst the catches of the main demersal fish; it contributes about 11% to the total weight of commercial landings.

This study is an attempt to give provisional estimations of the growth and mortality parameters of Spicara smaris, using length frequency data. Estimates of natural and total mortality are also given for assessment purposes. Yield predictions based on the relative yield per recruit model of Beverton and Hold (1964), require refining of the growth and mortality parameters.

2. MATERIAL AND METHODS

Fish were caught in the Saronikos Gulf (Figure 1) during spring and autumn periods of 1986, using a 420 hp trawler, towing a net with a cod-end mesh of 14 mm between stretched knots. Hauls were characterized by bottom depths between 50 m and 200 m. Samples were weighed and then frozen in deep freezers (-20 °C) in the laboratory. Measurements of total length (in mm), total body weight (in g) and sex determination were carried out in our laboratory. A conversion factor was used, where necessary, to convert our length data to the total catch.

Gonads were observed macroscopically (Stereo Microscope WILD M8) and microscopically (Microscope Olympus BH-2) and the maturity stages were classified according to Nikolsky's (1976) scale.

Growth parameters were extracted using the "integrated" method by Pauly (1983), i.e., plotting a growth curve through most of the peaks of our length frequency data. Estimations of K, L_{oo} were then obtained by the Ford-Walford plot, i.e.:

$Lt+1 = a + b*Lt$, where: $L_{oo} = a/(1-b)$ and $K = \ln b$

In our work, Lt and Lt+1 correspond to lengths separated by monthly intervals. Estimations of L_{oo} and Z/K using length frequencies are also given, computed through a recent method developed by Wetherall, Polovina and Ralston (1987) for data basis purposes.

This method was also presented and commented by Pauly in the 4th Technical Consultation on Stock Assessment in the Balearic and on Gulf of Lions statistical divisions (Charbonnier, 1986).

Natural mortality was estimated, for assessment purposes, through the equation derived by Pauly (1980):

$LogM = 0.0066 - 0.279*LogL_{oo} + 0.6543*LogK + 0.4634*LogT$, where

L_{oo} (total length in cm), K are the parameters of the von Bertalanffy growth equation and T is the mean annual temperature (in C) of the water in which the stock in question lives.

Estimation of the total mortality coefficient (Z) was obtained by means of a length converted catch curve following Pauly (1983a). Values of Z are also given through the formulae:

$$Z1 = \frac{K*(L_{oo} - \bar{L})}{\bar{L} - L'} \quad (1) \qquad \text{and} \qquad Z2 = \frac{n*K}{(n+1)*\ln(L_{oo}-L')/(L_{oo}-L)} \quad (2), \text{ where:}$$

L_{oo}, K are the parameters of the von Bertalanffy growth equation
L' is the smallest length of animals that are fully represented in catch samples
$\bar{L}$ is the mean length of fish in the catch, larger than L' (see also Pauly, 1983, 1984a).

The average length at first capture (Lc') was estimated through the resultant curve derived from the left side of the length converted catch curve (Pauly, 1984).

The Beverton and Holt (1964) tables of yield function were followed for the estimation of the relative yield per recruit curve.

3. RESULTS

3.1 Growth

Length frequency distributions during spring and autumn periods of 1986 are given at monthly intervals (Figure 2). Data are repeated twice according to Pauly (1983). For assessment purposes, the sexes were not considered separately; besides, the sex reversal of Picarel, occuring at the age of 2-3 years (cf. Salekhova, 1979) urged us to an overall consideration of sexes.

Following Pauly (1983), a "growth" curve was plotted through carefully selected peaks of our histograms (Figure 2). Estimations of K, L_{oo} were then obtained using the Ford-Walford plot and the regression line was computed as: $Lt+1 = 10.488 + 0.951*Lt$ with:

$L_{oo} = 212.4$ mm
$K(year) = 0.608$
$r = 0.99978$

According to Wetherall, Polovina and Ralston (1987), L_{oo} and Z/K can be computed through the relationship between $\bar{L}i$ and Li (Table 1, Figure 4).

The linear regression analysis of the rectilinear segment of the resulting curve (Figure 4) showed that:

$\bar{L}i = 66.256 + 0.669*Li$
$r = 0.998$
$L_{oo} = a/(1-b) = 200.3$ mm and
$Z/K = b/(1-b) = 2.023$

3.2 Length - Weight Relationship

The overall consideration of sexes showed that:

$$W = 4.131*10^{-5}*L^{2.700}$$

while for males it was found that:

$$W = 2.773*10^{-5}*L^{2.781}$$

and for females:

$$W = 2.217*10^{-5}*L^{2.827}$$

3.3 Maturity

Our observations on the maturity stages of Spicara smaris showed that the spawning period of this species in the Saronikos Gulf, occurs mainly during the months of April-May and partly in June (Figure 3).

3.4 Mortality

Natural mortality was calculated as M = 1.095 from the empirical formula of Pauly (1980), considering T = 16°C which corresponds to the mean annual water temperature of the Saronikos Gulf at depths of 100 m (Data according to the National Hydrographic Service of the Armed Forces of Greece).

The value of total mortality coefficient was estimated as Z = 1.206 through the construction of a catch curve (Table 2, Figure 5). The regression line is:

ln (N/ t) = 8.216 - 1.206*t with r = 0.9449.

The value of Z = 1.206 represents an annual mortality rate of: A = 0.701.

Formulae (1) and (2) give also estimations of Z1 = 1.211 and Z2 = 1.491.

These values represent annual mortality rates of A1 = 0.702 and A2 = 0.775 respectively.

3.5 "Selection"

The average length at first capture was computed as Lc' = 126 mm (Table 3, Figure 6); therefore, $C = Lc/L_{oo} \approx Lc'/L_{oo} = 0.593$.

3.6 Relative Yield per Recruit

Relative yield per recruit (Y'/R) in relation to the exploitation rate and length at first capture, is given for M/K = 1.75 by the use of Beverton and Holt (1964) Tables (Figures 7-11).

The parameters estimated for Spicara smaris in the Saronikos Gulf are given in Table 4.

4. CONCLUDING REMARKS

4.1 Growth

There is a vast number of methods for the estimation of growth, mortality and recruitment patterns and for deriving information from length frequency data (Pauly, 1985).

The "integrated" method by Pauly (1983) seems to "fit" in the case of Spicara smaris which is a relatively small fish, lives no longer than 3-4 years and appears to have one spawning period per year (cf. Salekhova, 1979), i.e., suggesting one cohort per year. Although fitting curves by eye seems to be arbitrary, this method may often be almost as good as any sophisticated approach (cf. Gulland, 1987). This, does not mean of course that the estimates obtained (L_{oo} = 212.4 mm, K = 0.608) should be considered as unbiased; besides, the difficulty of obtaining representative samples in fishery research is very well known and thoroughly discussed (Gulland, 1983). Thus, we also applied the Wetherall, Polovina and Ralston (1987) method, which gave estimates of L_{oo} = 200.3 mm and Z/K = 2.023. This value of L_{oo} is not considered representative of the stock, since we have fish in our samples bigger than 200 mm (L_{max} = 205 mm). Although values of L_{oo} smaller than the largest individuals in the length composition may occur, these are not likely to be the correct values to use (Jones, 1984).

The lack of literature data does not allow to split Z/K into Z and K according to Pauly and Munro (1984). Thus, in all our computations, the asymptotic length of Spicara smaris is considered as L_{oo} = 212.4 mm and its K value as K = 0.608.

The value of K = 0.608 seems to be rather high, however it may be close to reality considering that Spicara smaris reaches a total length of approximately 220 mm within three, rarely four years, i.e., it is a rather fast growing species. We should also notice that Spicara flexuosa (R), a closely related species, is characterized by a value of K = 0.50 (cf. Salekhova, 1979).

Nevertheless, validation of these estimates is necessary by using otoliths and size frequency data at younger ages, i.e., 0.25-0.5 years.

4.2 Natural Mortality

Natural mortality rate for Spicara smaris seems to be very high (M = 1.095) suggesting low fishing rates of F = 0.111-0.396 (For Z = 1.206-1.491) which may be regarded as being within reality, if we consider some biological features (small, fast growing, short lived) and the behaviour of this species which is characterized by distinct vertical and horizontal migrations (cf, Salekhova, 1979). The behaviour and migration pattern of Spicara smaris are not sufficiently known and the results obtained by the use of uncontrolled sampling should be considered with a great deal of caution.

We should also be aware of the superficial use of the empirical formula by Pauly (1980) for the estimation of natural mortality, particularly in cases of management proposals where the results may lead to disastrous conclusions. As keenly observed by Gulland (1984), the problem is not so much in the values of parameters as in the conclusions that may be expressed as "the stock is overfished" or "the present fishery mortality is below the optimum and the fishing effort can be increased".

4.3 Relative Yield per Recruit

The Beverton and Holt relative yield per recruit model is used only as a rough approximation of the assessment of the stock of Spicara smaris in the Saronikos Gulf. This approach, although perhaps not justified in a multispecies fishery, however, may be useful in cases where there is no relevant information. The disadvantages of this model have been often recorded and thoroughly discussed (Pitcher and Hart 1982, Gulland 1983, Pauly 1984a); one crucial limitation is the fact that the maximum Y'/R is produced in most cases at values of exploitation rates over 0.5, where the stock is "overfished". The choice of E0,1 a concept analogous to the F0,1 as suggested by Gulland (1984a), does not seem to alter the situation as also happens with our results (Figure 10). Similar observations are recorded in Charbonnier (1986).

It is difficult and probably unwise to describe the current position of our stock within definite limits, however Figures 7 - 11 show what actually happens if the parameters involved have been correctly estimated. Following Gulland (1984), who notes that the derivation of M as a function of growth and temperature (Pauly, 1980) implies a single standard deviation from 0.78 to 1.28 times the "best estimate" and the computation of Z implies a 20% error, we may conclude that our M values range from:

M = (0.85) - 1.095 - (1.40) and our Z values from:
Z = (0.96) - 1.206 - 1.491 - (1.79)

These estimates show that the M and Z values may overlap and the exploitation rate may vary from E = 0.00!! till E = 0.52. These observations probably allow us to conclude that the fish stock may not yet be "overfished", but they do not permit a specific definition of the current position. This situation is clearly shown in the threedimensional representation of Y'/R in relation to exploitation rate and length at first capture (Figure 9), where Lc = 126 mm and the level which determines the E values is absent.

Problems also exist due to the uncertainty due to the use of the "integrated" approach, in the estimation of K, which is the "ruling" factor in growth and stock assessment studies. Selecting two sets of values of K and M parameters close to our estimates, we can get the following results:

If $L\infty$ = 212.4 mm and Lc = 126 mm

K	M	M/K	Z	F	E	Eopt
0.50	0.90	1.80	0.99	0.09	0.09	0.93
0.50	1.20	2.40	0.99	*	-	1.00
0.608**	1.095	1.801	1.206	0.111	0.092	0.93
0.70	0.90	1.29	1.39	0.49	0.35	0.81
0.70	1.20	1.71	1.39	0.19	0.14	0.93

* : negative value of F , not accepted
** : our estimates

If the current position as regards the exploitation rate, is within the range of E = 0.092 - 0.266 and if Lc < Lc' = 126 mm, we may conclude that the maximum relative yield per recruit has been probably attained (Figures 9, 11). The value Lc = 96 mm has been arbitrarily chosen, however it may be close to reality since Tsimenidis (Unpublished data) records very low selectivity index for Spicara smaris (Selection factor: 3.15, Lc = 116 mm, fork length) trawling with a cod-end of 36.8 mm mesh ($\approx$20 mm between stretched knots) covered with a 27.9 mm net ($\approx$14 mm between stretched knots).

It is obvious that yield predictions require refining of the parameter estimates; therefore, the "integrated" approach for the estimation of K and Pauly's formula for the estimation of M should be avoided in further, more refined approaches.

Considering the weaknesses of Beverton and Holt model and the lack of relevant data, it would be thoughtless to proceed now to recommendations such as increase/decrease of fishing effort or increase/decrease of mesh size, based on our preliminary estimates.

The fact that the current position is probably traced on the left side and not at the top of the yield curve, shows that the objectives of management, i.e., the pursuit of economic targets, may be achieved (cf. Gulland, 1984a) provided that further investigations show that all or most of the commercially important fish stocks of the fishery are subject to a similar state of exploitation and the economic balances have been taken into account.

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Table 1

Length frequency distribution (%) of Spicara smaris in the Saronikos Gulf, Greece and determination of $\bar{L}_i$

AVERAGE LENGTH L_i (mm)	APRIL	MAY	JUNE	OCTOBER	NOVEMBER	$\Sigma\%/n$	$\bar{L}_i$ (mm)
107.5	0.0	0.0	0.0	0.0	1.6	0.32	148.28
112.5	0.7	0.0	1.5	0.0	0.0	0.44	148.41
117.5	1.6	2.6	6.9	0.0	0.0	2.22	148.57
122.5	5.6	8.8	17.3	2.5	3.2	7.48	149.28
127.5	7.0	9.3	13.8	5.1	9.5	8.94	151.52
132.5	10.6	11.2	12.7	8.8	11.1	10.88	154.18
137.5	7.8	6.7	9.5	12.6	9.5	9.22	157.57
142.5	17.5	14.5	8.5	8.9	7.9	11.46	160.62
147.5	7.4	12.9	8.0	13.9	4.8	9.40	164.86
152.5	9.8	5.4	1.4	10.1	6.3	6.60	168.98
157.5	2.2	4.5	4.2	11.5	15.9	7.66	172.27
162.5	2.7	5.2	1.5	3.8	6.3	3.90	176.72
167.5	1.8	5.5	3.5	3.1	1.6	3.10	179.31
172.5	3.9	2.2	6.9	4.3	4.9	4.44	181.30
177.5	2.3	4.3	0.9	5.8	6.3	3.92	184.10
182.5	8.8	0.7	1.5	4.0	9.5	4.90	186.68
187.5	5.1	1.4	1.9	4.2	1.6	2.84	190.68
192.5	2.2	4.8	0.0	1.0	0.0	1.60	194.65
197.5	1.5	0.0	0.0	0.4	0.0	0.38	199.71
202.5	1.5	0.0	0.0	0.0	0.0	0.30	202.50

Table 2

Data for the construction of the catch curve of Spicara smaris in the Saronikos Gulf, Greece, $(t = -\ln(1 - \bar{L}/L_{oo})/K)$

-CLASS LIMITS- LOWER (mm)	UPPER	MIDPOINT (mm)	N* (594)	t(low)	t(up)	Δt	$\ln(N/\Delta t)$	t(mid)
105.01	110.00	107.51	1	1.122	1.201	0.078	2.547	1.161
110.01	115.00	112.51	3	1.201	1.283	0.082	3.597	1.241
115.01	120.00	117.51	11	1.283	1.370	0.087	4.845	1.326
120.01	125.00	122.51	43	1.370	1.461	0.091	6.154	1.415
125.01	130.00	127.51	54	1.461	1.558	0.097	6.325	1.509
130.01	135.00	132.51	63	1.558	1.661	0.103	6.418	1.609
135.01	140.00	137.51	47	1.661	1.771	0.110	6.060	1.715
140.01	145.00	142.51	59	1.771	1.889	0.118	6.219	1.829
145.01	150.00	147.51	55	1.889	2.016	0.127	6.074	1.951
150.01	155.00	152.51	37	2.016	2.153	0.137	5.597	2.083
155.01	160.00	157.51	35	2.153	2.303	0.150	5.455	2.227
160.01	165.00	162.51	19	2.303	2.468	0.165	4.748	2.384
165.01	170.00	167.51	22	2.469	2.652	0.183	4.789	2.557
170.01	175.00	172.51	28	2.652	2.858	0.206	4.912	2.752
175.01	180.00	177.51	36	2.858	3.094	0.236	5.029	2.972
180.01	185.00	182.51	27	3.095	3.370	0.275	4.586	3.227
185.01	190.00	187.51	30	3.371	3.701	0.331	4.507	3.528
190.01	195.00	192.51	16	3.702	4.117	0.415	3.653	3.896
195.01	200.00	197.51	6	4.118	4.674	0.556	2.378	4.373
200.01	205.00	202.51	2	4.675	5.523	0.847	0.859	5.045

1/ Number of fish suitable for estimating Z according to Pauly (1984a)

Table 3

Derivation of the resultant curve of Spicara smaris in the Saronikos Gulf, Greece, using the left side of the length converted catch curve

-CLASS LIMITS- LOWER (mm)	UPPER	MIDPOINT (mm)	N	Δt (midpoint to midp.)	M(I)	M(II)	N/P	P	Cum P
100.01	105.00	102.51	0		1.095			0.0000	0.0000
105.01	110.00	107.51	1		1.114		106	0.0094	0.0094
110.01	115.00	112.51	3	0.080	1.132	1.123	97	0.0310	0.0404
115.01	120.00	117.51	11	0.084	1.151	1.141	88	0.1250	0.1655
120.01	125.00	122.51	43	0.089	1.169	1.160	79	0.5420	0.7075
125.01	130.00	127.51	54	0.094	1.188	1.178	71	0.7606	1.4680
130.01	135.00	132.51	63	0.100	1.206	1.197	63	1.0000	2.4680

Table 4

Summarized results for Spicara smaris (Saronikos Gulf, Greece)

Reference	Parameters estimated																
	L∝	K	Z	M	F	A (1)	E (2)	M/K	Z/K	Lc' (3)	c (4)	Z1 (5)	A1	E1	Z2 (6)	A2	E2
PAULY (1983,1983a 1984)	212.4	0.608	1.206	1.095	0.111	0.701	0.092	1.801	1.984	126.0	0.593	1.211	0.702	0.096	1.491	0.775	0.266
WETHERALL et al. (1987)	200.3	-							2.023		0.629					-	-

(1) A = 1-S (Annual mortality rate)
S = e^{-Z} (Annual survival rate)

(2) E = F/(F+M) (Exploitation rate)

(3) Lc': Average length at first capture

(4) C = Lc'/L∝

(5) Z1 = K*(L∝-$\bar{L}$)/($\bar{L}$-L')

(6) $Z2 = \frac{n*K}{(n+1)*\ln (L\infty-L')/(L\infty-\bar{L})}$

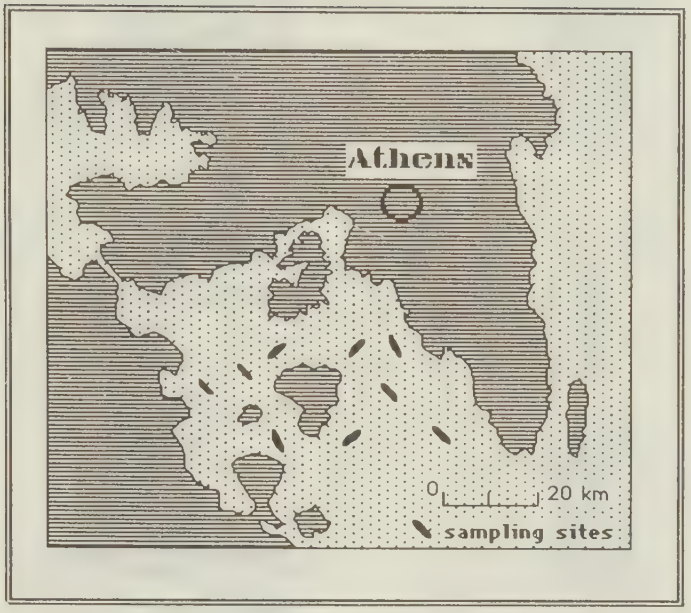

Figure 1 Map of the Saronikos Gulf, Greece and sampling sites

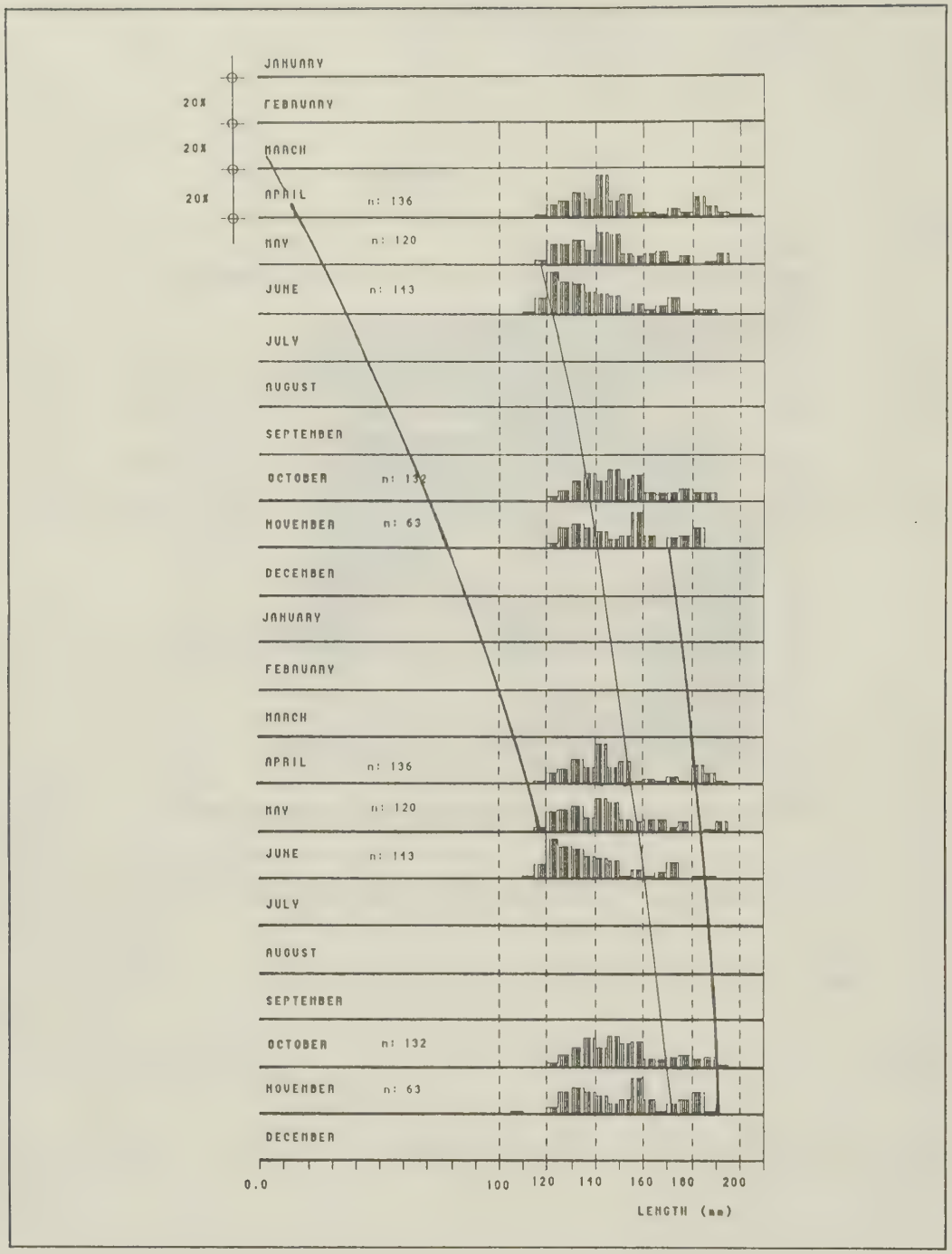

Figure 2 "Growth" curve of Spicara smaris in the Saronikos Gulf, Greece, based on length frequency distribution. (Data collected during the Spring and Autumnn periods of 1986)

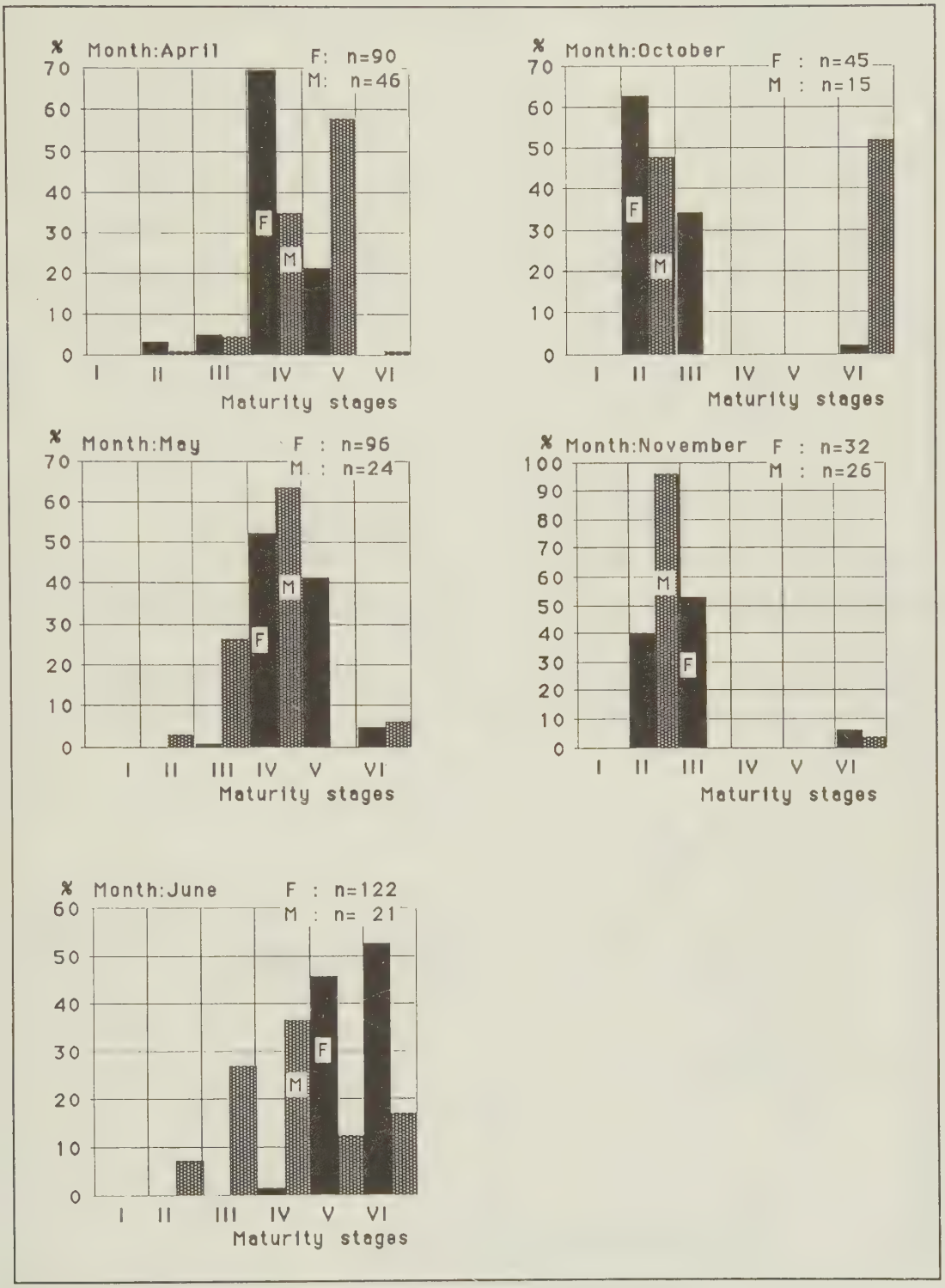

Figure 3 Distribution of maturity stages of Spicara smaris in the Saronikos Gulf, Greece

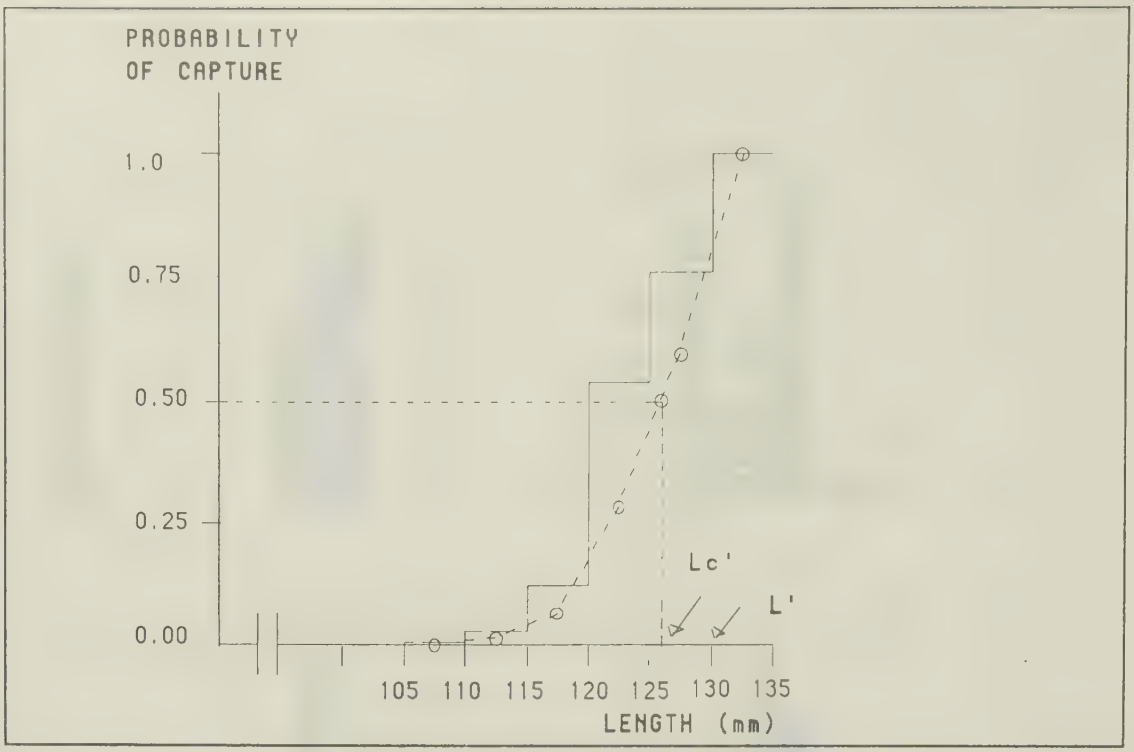

Figure 4 Determination of L_{oo} and Z/K of Spicara smaris in the Saronikos Gulf, Greece

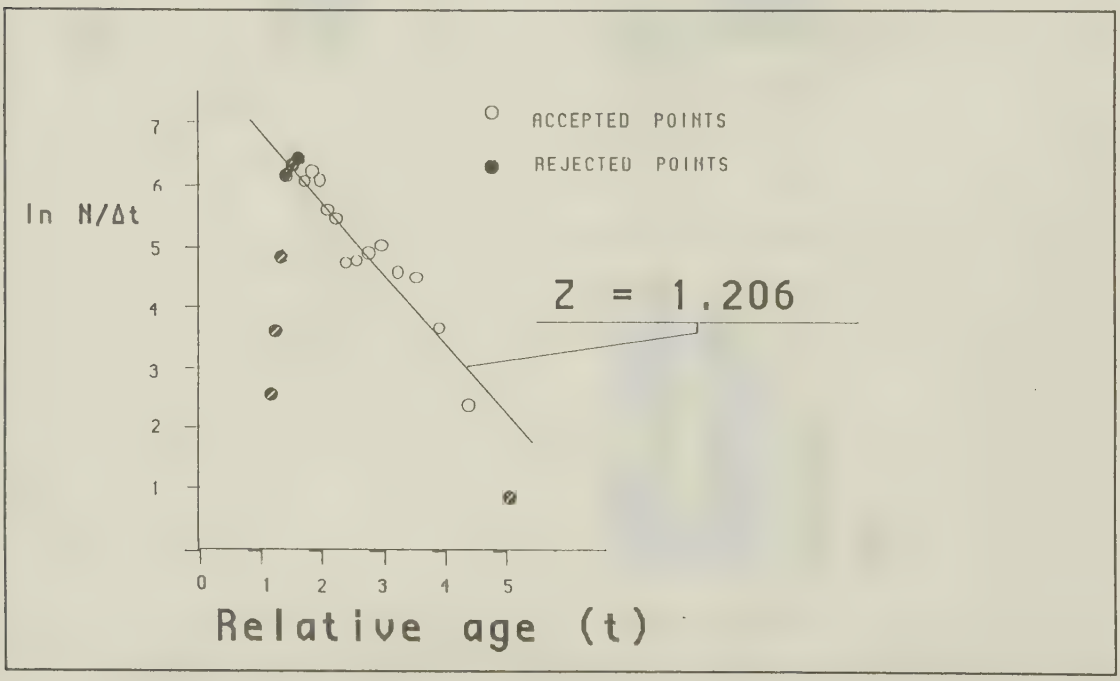

Figure 5 Catch curve of Spicara smaris in the Saronikos Gulf, Greece

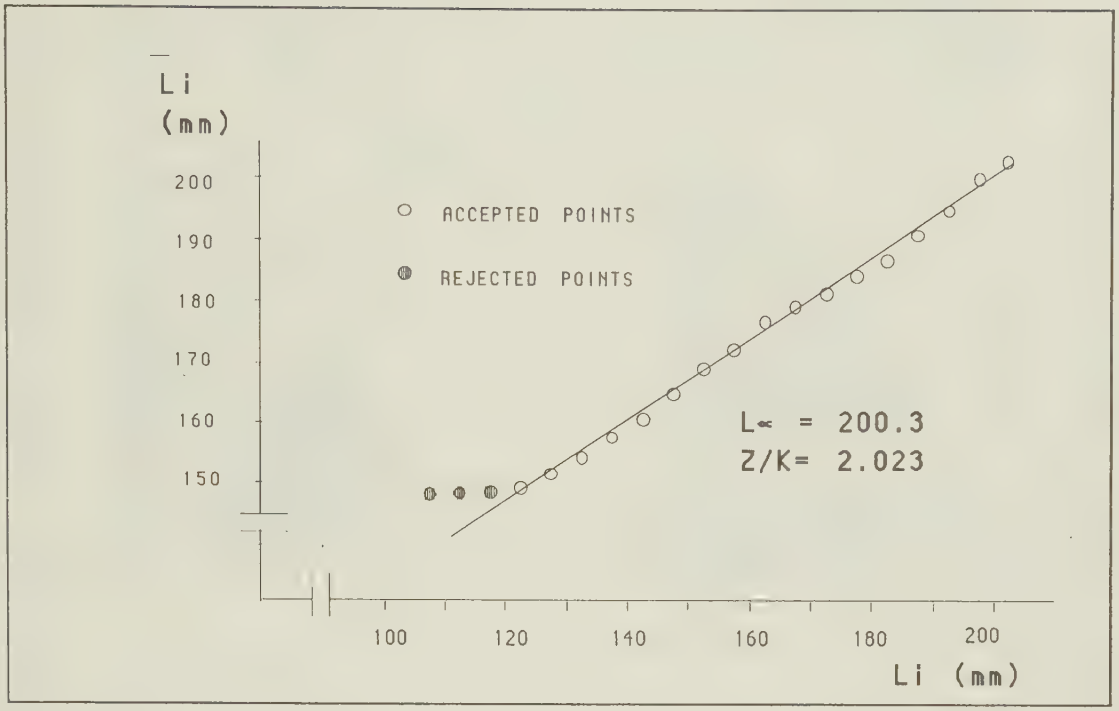

Figure 6 Probabilities of capture (continuous line) and resultant curve (dotted line) of Spicara smaris in the Saronikos Gulf, Greece for the estimation of Lc'

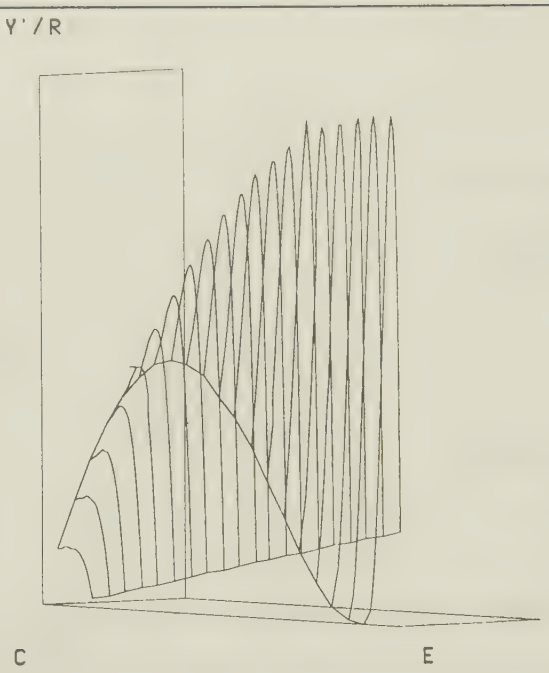

Figure 7

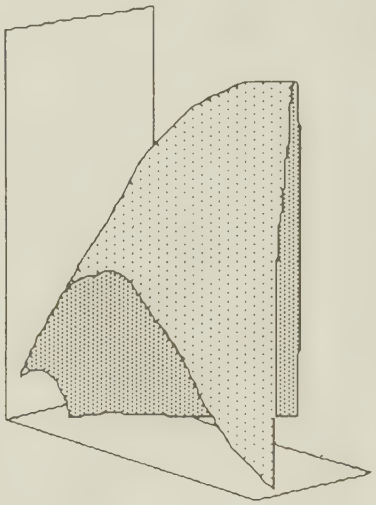

Figure 8

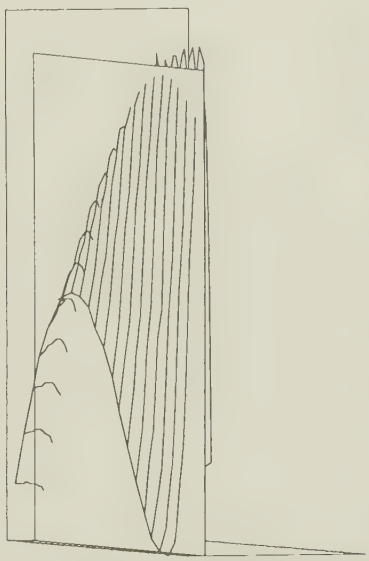

Figure 9

Three dimensional representation of the relative yield per recruit (Y′/R) of *Spicara smaris* in the Saronikos gulf, in relation to the exploitation rates (E) and lengths at first capture (C) for M/K = 1.75.

Figure 7 Computer aided graphic representation.

Figure 8 Outline of the"dome" shaped representation.

Figure 9 Section of the "dome" across the (C) axis at length capture Lc=126 mm, to show the likely current position.

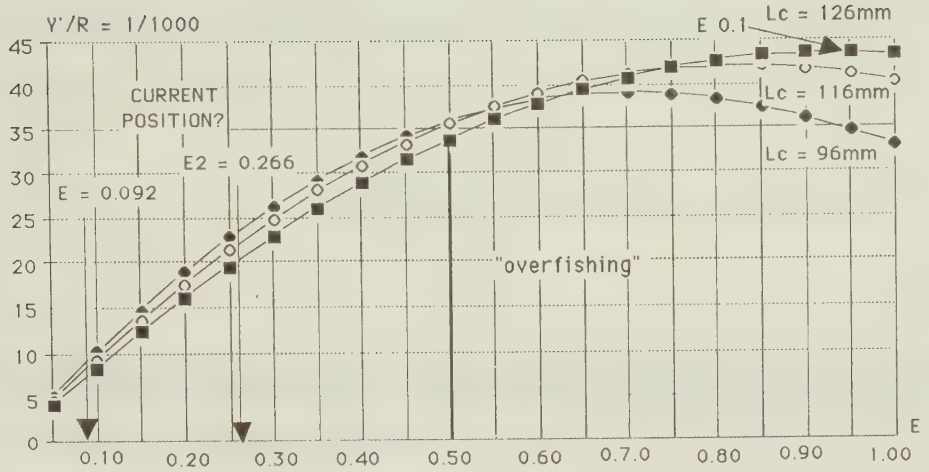

Figure 10 Relative yield per recruit (Y'/R) curves for Spicara smaris in the Saronikos Gulf, in relation to the exploitation rates. The three curves correspond to various Lc values including the Lc' = 126 mm from our data

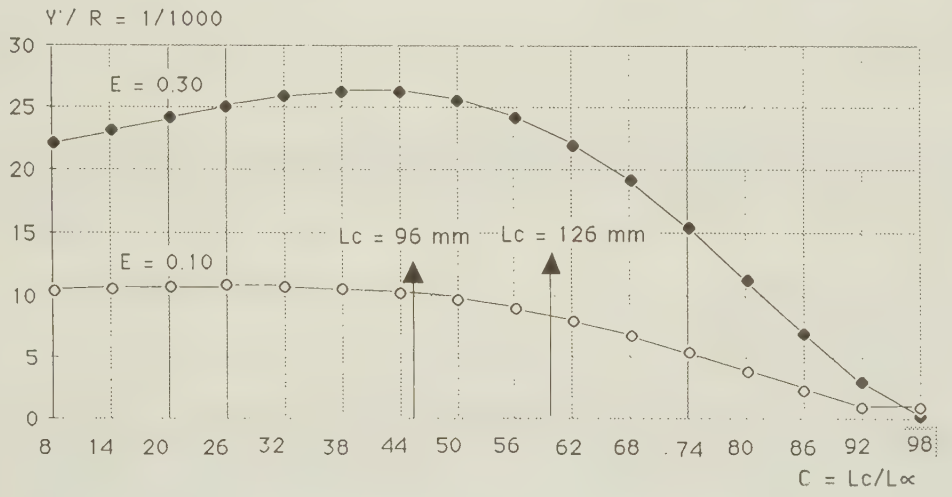

Figure 11 Relative yield per recruit (Y'/R) curves for Spicara smaris in the Saronikos Gulf, in relation to the C (L_c/L_∞) values. The two curves correspond to exploitation rates of E = 0.10 and E = 0.30

APPENDIX/ANNEXE L

Some Biological Parameters on the Red Porgy (Pagrus pagrus) in the Kastellorizo Area

by

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1. INTRODUCTION

The red porgy is a bottom dwelling Sparid with high commercial value, whose range extends through the Eastern and Western Atlantic Ocean, and into the Mediterranean Sea.

Its biology was studied off the North and South Western Atlantic coast by several authors, (Ciechomski and Weiss, 1973; Manooch, 1976; Manooch and Huntsman 1977; Manooch and Hassler 1978). In the Mediterranean, except some descriptions of eggs, larvae and juveniles provided by Ranzi (1969), the red porgy is not mentioned in other papers.

In the present work, information on length and age frequency distribution, growth in length and weight, mortality and reproductive cycle is presented for the red porgy stock around the Kastellorizo islands, as a contribution to the better knowledge of this species.

2. MATERIAL AND METHODS

Samples were collected seasonally from April 1985 to July 1986, except for the winter period when no sampling took place. Over 90% of the total number of individuals in the catch were taken by hook and line and the rest by bottom trammel net. Figure 1 shows the area of the study and the sampling stations.

For each specimen, fork length was measured to the nearest millimeter and body weight to the nearest gramme. Sex and maturity stage was determined according to Nikolsky's scale (1976). Age classification was based on scales taken from the left side of the body beneath the tip of the pectoral fin.

3. RESULTS AND DISCUSSION

3.1 Length and Age Composition

Red porgy caught off the Kastellorizo coast were grouped into 20 mm size intervals and the percentage of individuals in each interval was identified (Figure 2). Fork lengths ranged from 133 mm to 418 mm and ages from I to XII. Over 70% of the fish caught were between 180 and 280 mm FL. Fish smaller than 180 mm constituted 6.3% in number and those larger than 280 mm were 21.8% of the total number of specimens. The most frequently landed age groups were II and III, reaching 51% in the total catches (Figure 3). The scarsity of young individual with lengths smaller than 180 mm (ages 0+, I+) can be attributed to gear selectivity, since the hook and line fishery excludes completely or selectively smaller individuals from the catches. In the length range 360-420 mm FL there were few fish, fact related to the higher expected total mortality for the older specimens.

3.2 Growth in Length

Regression equations were derived by plotting projected (40x) scale radius (R) on fork fish length (L), and they were:

$L = 62.6 + 0.79 \times R$, $r = 0.99$, for the males
$L = 28.4 + 0.99 \times R$, $r = 0.99$, for the females.

The analysis of co-variance indicated no statistically significant difference in the body length - scale radius relationship, between the individuals of the two sexes ($F=0.69$, d.F.=116, $p<0.05$). Thus, data were combined and the regression obtained for the total number of individuals was $L = 29.8 + 0.98 \times R$, $r = 0.99$, which is presented in Figure 4.

Theoretical growth parameters were estimated from the back-calculated data (Table 1) and the von Bertalanffy growth equation. During the first year of life, individuals attained 35.1% of their

maximum adult size and then growth rates became less rapid (Figure 5). Mean annual increment for ages I to XII was 33.1 mm FL. The parameters of von Bertalanffy's equation, were derived as L_{oo} = 450.889 mm, K = 0.1181 and t_o = 2.826.

Manooch and Hassler (1978) reported for red porgy off the Carolinas L_{oo} = 746 and K = 0.096. The oldest fish caught, aged XV, had a total length of 694 mm.

3.3 Growth in Weight

The regressions of body weight (g) to fork length (mm), computed by the least square method for the 23 males and the 95 females, were:

$W = 3.43 \times 10^{-5} \times L^{2.92}$, r = 0.99, for the males
$W = 1.93 \times 10^{-5} \times L^{3.02}$, r = 0.98, for the females

Using the method of analysis of covariance no statistically significant difference was noted in the growth in weight between the individuals of the two sexes (F = 1.41, d.F. = 120, $p < 0.05$). The equation $W = 2.41 \times 10^{-5} \times L^{2.98}$, r = 0.98 describes the length-weight relationship for all individuals (n = 142) and it is presented in Figure 6.

3.4 Mortality

Total mortality rate was calculated for red porgy off Kastellorizo according to Pauly's method (1983). From the slope of the right limb of the catch curve, Figure 7, total mortality coefficient z was estimated to be z = 0.53. Manooch and Huntsman (1977) for red porgy off North and South Carolina found z = 0.44.

Natural mortality rate was computed according to Pauly's formula (1983) and had a value M = 0.16, and fishing mortality was F = 0.37. The exploitation ratio, E = F/F+M, was found to be E = 0.698.

3.5 Reproduction

Stratification of sexual maturity data by season, demonstrated a late winter to early summer spawning (Table 2). The peak spawning month was April, while in July all specimens collected were immature. Off the Carolinas, Walker (1950) found ripe red porgy in January and February and Manooch (1976) from January to April. Ranzi (1969) reported that in the Mediterranean Sea off Algeria they were sexually mature from April to June.

Length at first maturity could not be accurately determined, because of the small number of individuals in the catches. Nevertheless, from Table 3 it can be assumed that no individuals less than 200 mm (age II), and all fish greater than 320 mm (age VII) were sexually mature. Manooch (1976) states that although some individuals reached sexual maturity at age II, most spawned for the first time at age III.

Chi-square tests revealed a significant departure from the expected 1:1 sex ratio, when data were stratified by season (Table 2) and size (Table 3). Females were encountered more frequently in all length intervals and all months, and particularly in April and July when no males were caught, only the October males predominated in the catches. According to Manooch (1976), the discrepancy between sexes caught in favour of females, is probably due to the fact that the species displays protogynous hermaphroditism and thus, more females are available. Commercial Argentine landings also revealed a predominance of female red porgy in the catches (Manooch and Hassler, 1978).

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Table 1

Back calculated fork lengths of the red porgy in the Kastellorizo area from April 1985 to July 1986

	Calculated length at end of year											
Ages	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average length	139.3	185.2	217.4	242.6	265.4	287.4	309.1	330.5	351.2	371.5	384.7	396.8
Average annual increment	139.3	45.9	32.2	25.2	22.8	22.0	21.7	21.4	20.7	20.3	13.1	12.1
Annual increment %	35.1	8.1	6.4	5.7	5.5	5.5	5.4	5.4	5.2	5.1	3.3	3.1

Table 2

Percentage of sexual maturity stages and numbers of male and female red porgy in the Kastellorizo area from April 1985 to July 1986

Months	Maturity stages											
	I	II	III	IV	V	N	I	II	III	IV	V	N
April	8.3	50.0	20.8	8.3	12.5	24	0.0	0.0	0.0	0.0	0.0	0
June	0.0	7.1	22.6	6.4	0.0	31	0.0	66.7	33.3	0.0	0.0	6
October	50.0	50.0	0.0	0.0	0.0	2	0.0	81.8	18.2	0.0	0.0	11
March	0.0	65.0	20.0	5.0	10.0	20	0.0	58.3	0.0	33.3	8.4	12
July	29.4	64.7	5.9	0.0	0.0	17	0.0	0.0	0.0	0.0	0.0	0

Table 3

(a) Number of male and female red porgy grouped into 20 mm size categories, with chi-square values obtained from testing a 1:1 sex ratio. (b) Number of immature and mature red porgy in each 20 mm size interval

Lengths	a				b	
	o	o	Total	.	Immature	Mature
120-140	0	0	0	0	0	0
140-160	1	0	1	0	1	0
160-180	2	1	3	11.16	3	0
180-200	8	4	12	9.49	12	0
200-220	17	9	26	50.98	25	1
220-240	18	3	21	41.99	21	0
240-260	14	3	17	50.98	16	1
260-280	12	2	14	64.00	14	0
280-300	9	1	10	0	10	0
300-320	4	0	4	0	4	0
320-340	2	0	2	0	1	1
340-360	1	0	1	0	0	1
360-380	3	0	3	0	0	2
380-400	3	0	3	0	0	3
400-420	1	0	1	0	0	1

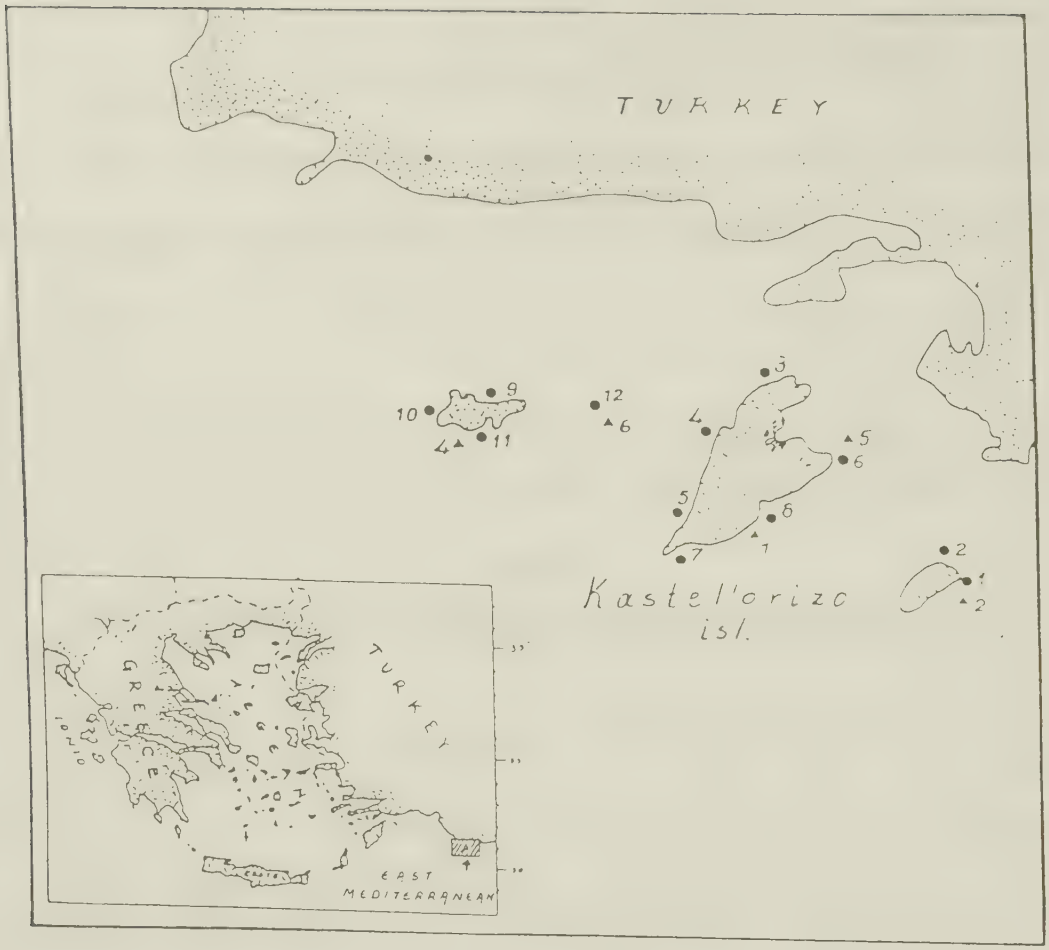

Figure 1 The area of the study and the sampling stations (• trammel bottom net, ▲ hook and line)

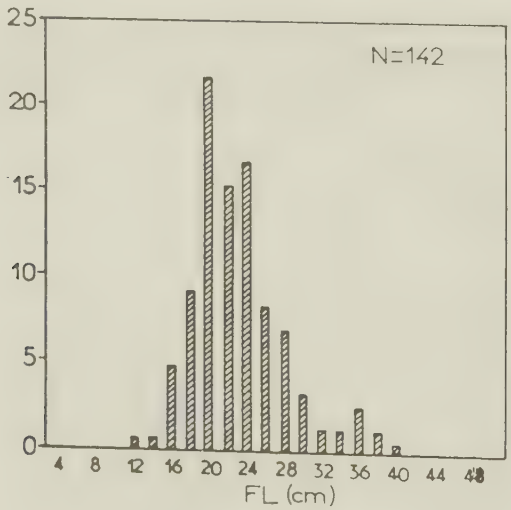

Figure 2 Length frequency distribution of the red porgy caught in the Kastellorizo area from April 1985 to July 1986

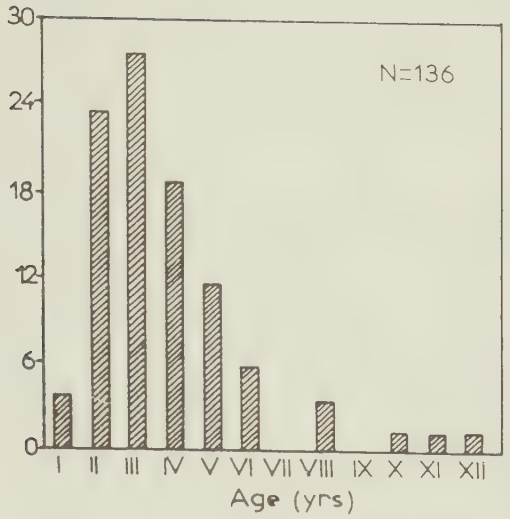

Figure 3 Age distribution of the red porgy caught in the Kastellorizo Sea from April 1985 to July 1986

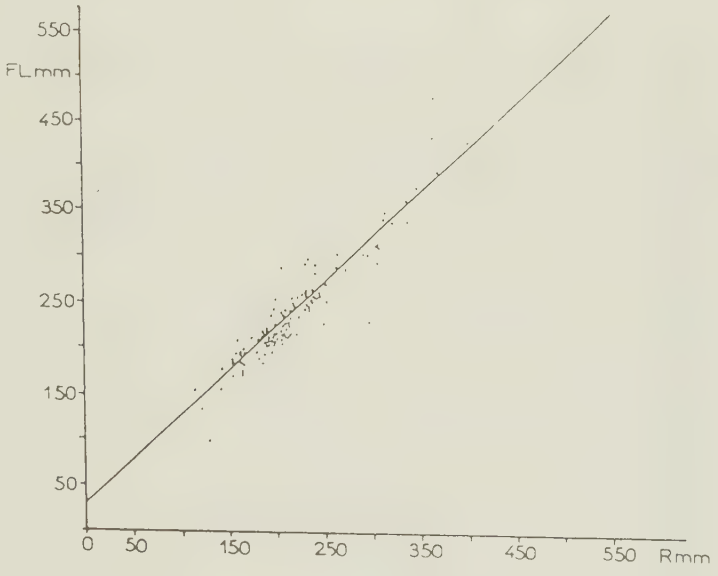

Figure 4 Body length (FL) Scale radius (Rmmx40) relationship

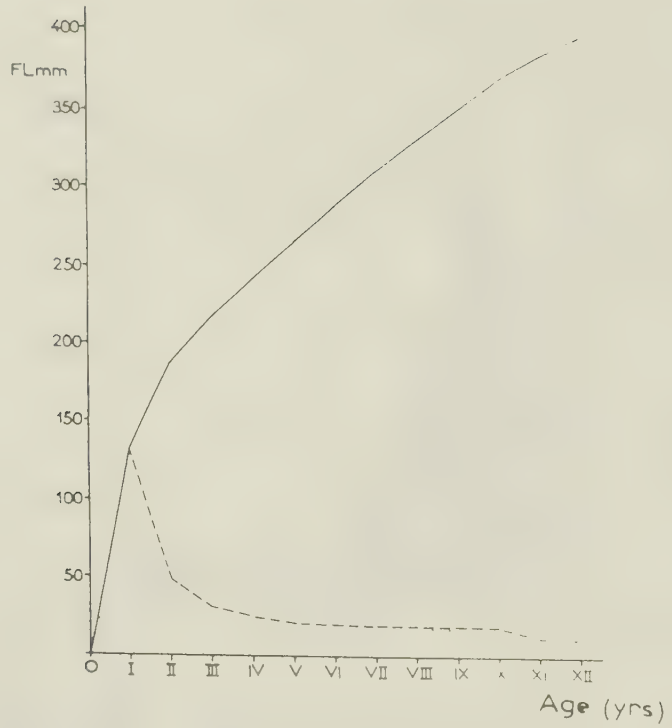

Figure 5 Total (—) and annual (--) growth curve of the red porgy in the Kastellorizo Sea from April 1985 to July 1986

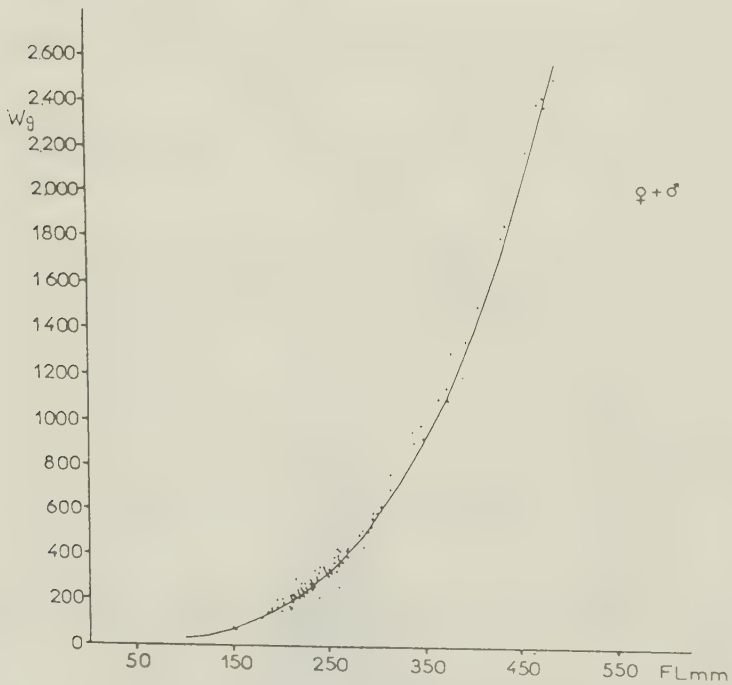

Figure 6 Length (FL) - Weight (g) relationship

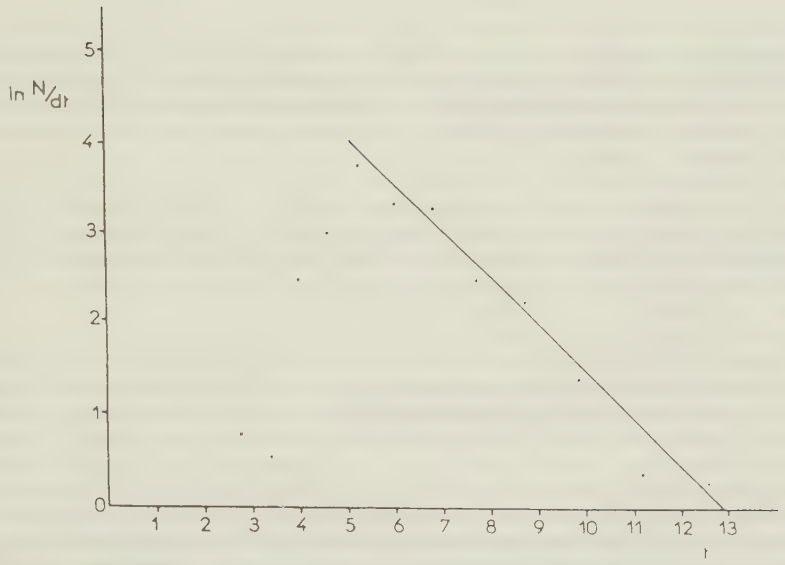

Figure 7 Catch curve based on lengths converted to ages for the estimation of total mortality

APPENDIX/ANNEXE M

A Research Strategy in Support of Stock Evaluation of Demersals in the Mediterranean Sea

by

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ABSTRACT

Theoretical difficulties arise in making yield calculations when exploitation begins early in the life cycle, principally because constant values for important parameters cannot be assumed, and because simple growth functions do not adequately describe the early growth in weight, or the length-weight relationship for juvenile fish.

An approach to yield modelling is suggested based on the Thompson-Bell procedure, which is based on research sampling cohorts at regular, short intervals throughout the first few years of life, in order to supplement data collected by a commercial catch sampling scheme, and to obtain data on the early growth, and on trends in recruitment.

For many fish stocks, exploitation begins in their first year of life, and this is also true for many fisheries in the Mediterranean. Such a situation poses some theoretical problems, which are addressed here in a preliminary way. The main theoretical problems and alternative approaches suggested toward overcoming them are:

- biases due to applying von Bertalanffy growth curves for juvenile fish where absolute values of t(0) diverge widely from the origin can be reduced by a more adequate range of sizes and ages in the samples used. They may also be partly overcome by better fitting procedures, but at the same time, fitting a simple growth function to fish lengths may not be the optimal solution to yield modelling, especially for young fish. Thus, in yield models, growth may be better expressed empirically in terms of mean weights at known, but not necessarily constant, calendar intervals from the birth date.

- For juvenile fish, retention by the commercial gear and/or their availability on the fishing grounds, are often partial, and this needs to be specified in yield calculations based on specific studies on juvenile fish.

- From a range of investigations reviewed on larval and juvenile fish, it is clear that the natural mortality rate for typically highly fecund marine fish typically drops sharply from high values shortly after spawning during egg and larval stages, to the lower values normally applied in fisheries yield studies as constants at or around the age at maturity, when the species is being exploited commercially. It is suggested that a system of regular sampling of the juvenile fish stocks throughout the year, in combination with yield modelling, may help to provide a more reliable approach to parameter estimation.

The problems in applying classical assessment approaches based on analysis of port samples and biomass (research vessel) estimates in Mediterranean fisheries is acknowledged. The strategy outlined here of regular recruitment surveys, followed by fisheries forecasts (including the impact of closed seasons), offers one possible alternative or supplementary approach, which may be better adapted to the administrative needs of most fishery management systems in the Mediterranean region.

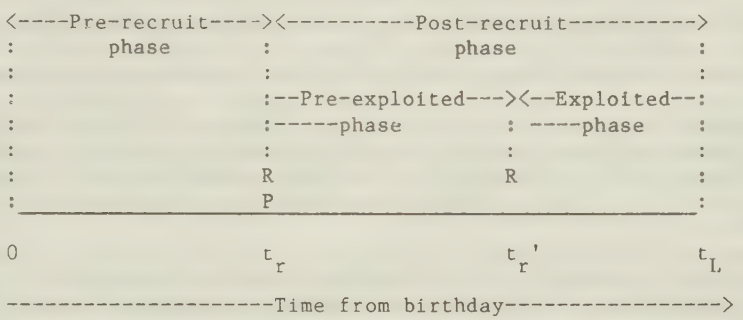
INTRODUCTION

In areas where fishing intensity is high and size at first capture low, such as many areas of the Mediterranean Sea, it is often difficult to predict the effects of a change in the way the fishery is prosecuted on the subsequent yield.

In practice, there have been few documented cases where the actual effects of a decrease in fishing effort, an increase in mesh size, or a change in the duration of a fishery, have been measured, and this emphasizes the importance of making the assumptions of any yield calculation as realistic as possible. The uncertainty is particularly acute for a fishery which starts exploiting the juveniles. In one such case (see Demetropoulos and Garcia, 1986), the effects of a short seasonal closure while the juveniles were on the nursery ground appeared to have been surprisingly positive compared with what one might have expected from standard yield per recruit calculations; making one doubt if an improved yield per recruit (Y/R) was the only factor involved. Probably an increased number of recruits entering the fishery was also the case.

These kinds of uncertainties as to whether standard single species Y/R models can be usefully applied, are fairly widespread in tropical fisheries where small sizes at first capture are common. They seem to call for a revision of our approaches to yield simulations, and the research approaches that underline them, especially where juvenile individuals are a significant part of the catch.

It may be useful to recall the theoretical basis for the yield per recruit formulation proposed by Beverton and Holt (1957), as reproduced with slight modification in the following diagram:



The above authors defined an age t_r at which the species is present on the fishing grounds, but which only become vulnerable to capture by the gear at some later age t_r'. This is a reasonable description of the situation for many fisheries, but for example in the Mediterranean, in some fisheries, e.g., for 'bianchetti' (juvenile small pelagics), exploitation begins soon after the juvenile fish have terminated their pelagic (larval) life history.

Growth estimates and studies of the early life history

During the First Technical Consultation on Stock Assessment in the Eastern Mediterranean (FAO, 1986), it was clear that considerable efforts have been made on a national basis toward age reading and growth rate estimation of Eastern Mediterranean species. At the same time, the generally high fishing pressures have made it difficult to obtain material for the whole of the life history of some heavily exploited species. Since emphasis in the Mediterranean area has been principally on the use of hard skeletal structures for basic estimation of age and growth of fish, information on the typically fast phase of early growth during the first 2 years or so of life is rarely available over shorter time intervals. This has usually restricted the number of estimates of size at age to a very limited number, separated by intervals of 1 year. Alternatively the use of size frequency analysis has been attempted which has allowed only the few earlier age groups to be identified. Using material from either source alone, with methods in current use for estimating parameters of the von Bertalanffy growth equation, tends to underestimate K and overestimate t_o and/or L .

Re-examining the problem would suggest two approaches to growth modelling:

(a) size and age data over a wider age range, and over time intervals of less than 1 year for the first few years of life.

(b) For ease of modelling, it is not necessarily optimal to work in terms of fish lengths fitted to a simple growth function, since the use of growth data in yield modelling is almost always concerned with fish weights and biomasses.

Whatever the approach adopted to mortality and growth estimation, there is a need for addressing the special priority common to most Mediterranean fisheries, of concentrating on the population dynamics of the earlier life history stages, in order to provide a better understanding of the following questions which are of fundamental importance to proper resource evaluation:

(1) What are the impacts of mesh size changes?

(2) What are the interactions between inshore ("petits métiers") and (industrial) offshore fisheries?

(3) What is the best strategy for protection of juvenile stages/nursery areas?

(4) What are the likely impacts of fishing seasons on the yield?

The present document attempts to suggest a broad research strategy to tackle the kinds of problems raised by the questions given above, and addresses some of the problems faced in making yield calculations under these circumstances. These may include the following problem areas:

(1) Fitted growth curves such as the von Bertalanffy function rarely provide a good description of size at age in the first one or two years of life, and this poor fit is accentuated, as in the Mediterranean, where large negative values of t_o are often recorded in the literature. A new approach (Stamatopoulos and Caddy, in press) is now being evaluated, which can be used for irregular time intervals, and appears to give "unbiased" estimates of von Bertalanffy parameters.

(2) Cohorts may be only partially retained by the gear in the first few years of life, making knife-edge Beverton and Holt calculations misleading, particularly if fishing intensity is high. On the other hand, with very small mesh sizes (<40 mm), the effective selectivity of the gear may be low, and sometimes, in the case of fisheries for juveniles, it may be that apparent increases in retention with age are due to increased availability to capture with time (e.g., migration onto the grounds) and not to selectivity per se.

(3) The assumption that natural mortality rate is constant with age from age at first capture is dubious under these circumstances. The literature on early life history processes suggests that a steeply declining function for M, smoothing out to a more or less constant value after the first few years of life, is more or less typical of highly fecund marine fish species.

(4) Modelling yield in terms of length instead of the biologically and economically more meaningful measure of body weight, offers some advantages in terms of field procedures; namely greater ease of measurement of fish, especially at sea. However, the subsequent conversion of lengths to ages and then to age-specific weights, can introduce biases which can be high for young fish. Working primarily in terms of age-specific weights (as is commonly the procedure for example in the ICES area), allows conversion factors to be eliminated from the calculations (except perhaps for mesh selection studies).

(5) Most yield calculations are carried out in reference to age, and not cross referenced to season of the year. A more specific calendar reference for time converts the yield per recruit calculation into a yield simulation in which real levels of fishing mortality during each season can be specified and incorporated. This allows the effects of seasonal closures to be examined (see, e.g., Garcia and Van Zalinge, 1982).

An alternative to using fitted growth curves in yield calculations

Growth functions such as the von Bertalanffy fitted to length at age are useful when comparing different populations and species, but a serious source of bias becomes evident (as shown by the vertical arrows in sector O-B-A of Figure 1) when $t(o) << 0.0$, as is often the case for Mediterranean demersal fish species for example. This bias can be partly overcome by using seasonalized modifications of the von Bertalanffy growth function (e.g., Lockwood, 1974; Pauly, 1984), but only at the expense of the need to define extra parameters.

Other approaches exist to growth modelling. Thus, using an array of mean weights at age leads more directly to yield and production estimates, and is not in theory much more difficult to implement, if regular samples taken by a juvenile fish sampling programme at intervals throughout the year which are available for weighing and age reading.

A problem with exclusively length-based methods relates to biases that occur in conversion of mean lengths into mean weights for small individuals. The obvious biases which result from using a single weight-length relationship of the form $w = aL^b$, have been addressed by various authors, including Pienaar and Ricker (1968), Houghton and Flatman (1978), Nielsen and Schoch (1980), and more recently Beyer (1987). These seem to be of three kinds:

(1) The need to correct for an underestimate of the true mean weight resulting from a simple deterministic length-weight equation.

(2) The fact that regression fits are particularly sensitive to outlying values at the end of the size range. Biases in outliers are particularly likely to occur, since allometric growth is more pronounced for juveniles.

(3) Seasonal variations in condition factor are rarely incorporated. These affect mature fish more than juveniles.

It seems unlikely, given the above situation, that a single two parameter relationship will accurately describe the length-weight relationship for both mature and immature, or mature and spent individuals, throughout the year. For example, a loss in body weight of up to 30% can occur for soles following spawning (De Clerk, 1981), and this is not atypical of other highly fecund species.

The use of direct estimates of mean weights for age groups obtained from a seasonal sampling programme should avoid most of these problems, especially where variations from isometric growth are most pronounced, and where seasonal variations in condition are important.

Gear selection

Small fish are usually only partly available to the gear, for one or both of the following reasons:

(1) They are only partially retained by the mesh.

(2) They may not all be present on the fishing grounds.

In both cases, this affects the appropriate level of F to use in the yield calculations.

Partial gear retention is typically determined from mesh selection experiments involving measurements of the size of individuals retained by the mesh as opposed to those in the cover, or as a rough approximation, from catch curves on length (Pauly, 1984): (Here, however, care has to be taken to distinguish the effects of availablity from those of gear selection). Alternatively, virtual population or cohort analysis by lengths provides a measure of the combination of selection by, and availability to, the gear for the species in question.

Normally, fish length is measured during selectivity experiments and subsequently converted to the corresponding weight. This involves the same problem of length weight conversion discussed in the previous section. However, measuring both weights and lengths for a limited number of fish in each size category during selectivity experiments should preserve the options to express partial retention in terms of weight as well as length.

Variations in natural mortality rate with size and age

It seems generally accepted in the literature (e.g., Ursin, 1967; Pauly, 1984), that mortality rate declines with size and age, and that this decline begins in the larval stage (Pearcy, 1962; Cushing, 1975). Establishing age specific values for M, particularly for an exploited species, is far from easy however, and even in the usual case where a single constant value of M is adopted throughout the commercial size range, this value is at best a rough estimate. This is the reason that most early yield calculations for a species are repeated for a range of M values.

Given that 4 causes of natural mortality are usually distinguished, namely predation, disease, starvation and senescence, most theoretical treatments of mortality rates consider the first of these to be usually predominant, except possibly for larval and very old fish. Obviously, the risk of death from predation is a function of abundance and of feeding activity of predators. Abundance, and hence density-dependent mortality effects (e.g., Cushing, 1975), are most evident for those small organisms which are numerically dominant in the size spectrum of living and dead organisms in the sea (Platt and Denman, 1977), and feeding rate here also declines with size to a close to constant value for larger fish (Caddy and Sharp, 1986). Thus, the probability a particular organism has of dying of natural causes should show a rapid decline with size, and it seems likely that this will also show up in the rate of change of M with size.

It is not obvious from the literature however, what is the best formulation to adopt for the relationship between M and age in marine fish, and establishing this must be an important research priority in future years; this again will require a knowledge of young fish dynamics.

Several approaches may be cited:

(a) Saila and Lough (1981) used a Weibull distribution to model survival of larval herring with time t (Figure 2); using the following expression:

$Z(t) = (c/b) \cdot (t/b)^{c-1}$, where b is the scale parameter, and c is the shape parameter.

(b) Cushing (1975) proposed that natural mortality is a density dependent function of age, between hatching and the critical age T (defined as the age of maximal biomass for an unexploited cohort, where growth and mortality rates are equal). The general trajectory of mortality with age (Figure 3) can be defined by two points; the mortality at age T (which we may regard as roughly equivalent to the age at full exploitation used in

standard approaches), and one or two earlier, higher mortality rates during the larval stages. Obviously, this approach ignores complications or discontinuities in growth and mortality that are likely to occur at or subsequent to metamorphosis, but for well-studied species, estimates for larval mortality rate are available. Assuming that the conventional constant M value applies at around age at full maturity, this seems to offer a reasonable basis for defining a rough survivorship curve under unexploited conditions.

Empirical approaches:

Peterson and Wroblewski (1984) followed up on the work of Kerr, Platt and Denman on size spectra of particles suspended in the sea, and found a relationship between dry body weight (w) and M for a range of organisms in the pelagic ecosystem as:

$$M\ (w^{-0.25}) = (1.92\ yr^{-1})\ w^{-0.25}$$

expressing this in terms of wet weight, and assuming with these authors that dry weight = 0.2 (wet weight),

gives: $M\ (w) = (1.92\ yr^{-1}) \times 0.2\ w^{-0.25}$

where: w = mean wet weight

Typical values predicted by this equation are:

wet weight:	10 g	M = 1.615
	1 000 g	M = .510
	2 000 g	M = .224

To what extent the values generated by the above approach are valid in absolute terms, and more particularly, in relative terms with age, is uncertain. Presumably they are not to be applied to demersal resources.

For the moment, it is of interest to note that M is generally a function of body weight, and is usually considered to decline to a close to constant value by maturity. A research approach that combines monitoring of abundance with age for the first few years of life, with simulations using different vectors of M, should help narrow the likely range of mortality values that are reasonable.

It should be remembered here also, that exploring the consequences of likely but imprecisely defined situations lies fully within the field of stock assessment. Using a simulation approach based on a range of likely values is preferable to sticking to assumptions that may have spurious exactitude, but in reality are likely to be incorrect! Even if precise values cannot be given to parameters such as M, the consequences of juvenile M values being higher than for adults can be explored in one of a series of simple simulations of the situation, which can then be compared with field sampling data.

Strategies for research in fisheries

There are perhaps three main aspects to defining the appropriate strategy for assessment work by research scientists in support of fisheries management:

- defining the best strategy for fisheries management and the management measures to achieve this;
- designing data collection procedures in the field;
- defining the best approach to yield modelling.

These 3 aspects are commented on in the following:

(1) Defining the best strategy for fisheries management

To date, there have been few if any fisheries in the Mediterranean where the concept of a TAC or Total Allowable Catch has been applied such as is commmonly used in the North Atlantic. To some extent, this is because the administrative infrastructure is not available in most countries, but also because the diversity of the fish fauna, and the diversity and generally small size of the fishing units make such a scheme impractical for most fisheries. Where management has been attempted, it has largely aimed at specifying allowable gear types, and the times and areas of access to the resource, and in reducing social conflicts between participants.

The urgent objective of controlling fishing intensity is of course only partly addressed by most regulatory systems of this type, but it can still be useful to have even a limited capability of forecasting changes in resource abundance particularly in anticipation of the above-mentioned management measures.

It can be readily understood that this approach calls for a regular system of monitoring of the annual abundance of young fish, in addition to having some idea of the catch and effort of older fish by the commercial fleet.

(2) Designing the data collection procedures in the field

A brief review of fisheries assessment approaches in North Atlantic fisheries shows that in oversimplified terms, a three-pronged approach is being taken to assessment:

(a) standing stock size is estimated annually or seasonally for key single stocks, and estimates of recruitment and abundance obtained in a routine way (by research vessel surveys).

(b) Commercial sampling of key stocks is carried out, including measurement of sizes and routine age reading of fish sampled at sea and in port. Age length keys are constructed and updated in order to enable the age composition of the catch to be determined.

(c) Biological investigations of size and age at maturity, spawning, feeding and ecological interactions are carried out using commercial and research vessel samples, and estimates of growth and mortality rates are made: the fishing mortality rates being largely based on cohort analysis. Yield models are constructed, and predictions are made of the impact of different fishing regimes on the total catch.

Clearly, the main elements of this greatly simplified scenario would need to be retained if real-time management by TAC's (set yearly), were to be attempted for single stocks in the Mediterranean.

If this is <u>not</u> the case, and the objectives are limited to:

- working toward optimum management over the long term;
- providing a degree of understanding of the likely impact of changes in the way the fishery is carried out;
- providing a limited forecasting capability;

then a more limited set of research approaches could be realized, that retained the following elements above, namely:

(a) an <u>index</u> of stock size and recruitment is obtained in a routine way annually for key single stocks, by research vessel operations. These aim particularly to survey nursery areas at the time of year when juvenile abundance can best be estimated. Ideally, these estimates could form part of a stratified research vessel survey of the whole stock, but may be confined to surveys of nursery areas with fine mesh gear over a series of transects. (In this second case, the synoptic survey of the main nursery areas may be combined with a series of regular samplings of one or two transects throughout the year, at least until the optimal timing of a single survey is established).

(b) Commercial sampling of key stocks is often difficult in the Mediterranean, and may have to be confined to indicative sampling on commercial vessels, simulated commercial fishing (vessel charters), and occasional commercial samples purchased in port (though here, the high unit cost of fish makes this infeasible for many species). Age and growth estimation should be possible, but estimates of the age composition of the whole catch will often be difficult. Although estimates of total catch by species may be feasible, estimates of fishing effort may have to be calculated based on the known catch rates of a standard boat category. Mortality rates are likely to be derived from catch curve analysis of research samples.

(c) Biological investigations of size and age at maturity, spawning, feeding and ecological interactions, are carried out using research vessel samples. Yield models are likely to be restricted to production models and yield per recruit analyses. <u>However</u>, if recruitment indices are available, estimating the likely change in catch levels (assuming the same fishing mortality as the previous year) may be possible. Rough predictions of the impact of different fishing regimes on the total catch should still be possible.

(3) Defining the best approach to yield modelling

Assuming that the following data are available:

(a) time series for an annual recruitment index for key species, i.e., relative abundance of a year class/species, or its mean catch per standard haul over a series of transects through the area of distribution of young fish, at a standard time of year.

(b) Growth rates (expressable preferably in terms of mean body weight of a cohort of known age with time where recruitment occurs at a discrete period of the year).

(c) A (range of) estimates of the natural mortality rate for the sizes and ages of interest. (This is the most difficult parameter to establish, but orders of magnitude for juvenile fish might be established by following the evolution of catch rates in an experimental survey repeated at regular intervals).

A simple approach to modelling yield changes is possible, illustrated in Table 1 based on the Thompson-Bell approach described in Ricker, 1975, using a spreadsheet (here, with Supercalc 3a software; available on many microcomputers).

Table 1 examines the yield per recruit of a population that migrates to offshore areas following a period on the inshore nursery area, and is fished separately by two different (and non-overlapping) fleets with different characteristics in the two areas. This model allows the effects of different parameters on the yield per recruit to be calculated, as well as the effects (oversimplified perhaps) of changes in inshore and offshore effort, and of mesh size.

Clearly, simulations of this kind, with a variety of assumptions, are useful in predicting the effect of different changes in the fishing regime.

RECOMMENDATIONS FOR A RESEARCH PROGRAMME IN SUPPORT OF YIELD MODELLING

The data base that would be necessary to support a yield modelling approach such as that proposed here would not differ substantially from that aimed at length-based approaches to assessment, but would emphasize several new elements, namely:

- carry out small mesh surveys of nursery areas at intervals of 1-3 months to determine size distribution of juveniles. As with length based methods, modal analysis of length frequencies would be a main tool to determine size at age for 0- and 1- age groups, and for a smaller sample for each (0.5-1 cm?) size class, total body weights would be estimated.

- If trained manpower is available, the age of this subsample could be determined from otoliths; supplemented by modal analysis which provides a more flexible approach for the first few years of life. In either case, the mean weight at age can be obtained for that subsample of each age which was sampled.

- An improved knowledge of nursery areas and seasons, and timing of migrations, will be important to further developing this yield modelling approach.

- The importance of research toward a better understanding of the factors determining juvenile mortality rate has to be emphasized.

- The effects of predation, and of discard mortality of juvenile fish may need investigation and incorporation into the model.

- The presence of a significant stock size of adult fish both as a reservoir of spawners and as potential predators needs establishing.

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Table 1

Y/R calculation (Thompson-Bell) by spreadsheet using weight specific inputs and inshore and offshore stock components under the assumption that M (hypothetical value) declines reciprocally with age

INPUT F(i)=		.5F(0)= .3								OUTPUT			
					%retained by gear		M (age)	Fishing mortality		Stock size		Yield in Kg	
Age (months)	mean wt (kg)	delta t	% stock inshore	% stock offshore	inshore	offshore		inshore	offshore	inshore	offshore	inshore	offshore
0										1000	0		
3	.001	.25	.99	.01	.001	0	3.1709	.0005	0	488.0276	4.526098	.0000854	0
6	.007	.25	.8	.2	.03	0	1.5657	.015	0	243.8585	2.048302	.0078506	0
9	.12	.25	.56	.44	.2	.1	1.030633	.1	.03	103.8010	33.25116	.3598704	.0855379
12	.24	.25	.42	.58	.6	.2	.7631	.3	.06	44.12762	46.25746	.9098563	.2586419
18	.44	.5	.21	.79	.8	.3	.4955667	.4	.09	12.12959	42.67345	1.346437	1.225637
24	.77	.5	.03	.97	1	.6	.3618	.5	.18	1.068534	32.30559	.2571240	3.227094
30	.8	.5	.04	.96	1	.7	.28154	.5	.21	.9031514	24.69057	.2210064	2.386077
36	.89	.5	.05	.95	1	.9	.2280333	.5	.27	.8892279	19.21623	.2386621	2.586004
48	.95	1	.08	.92	1	1	.16115	.5	.3	.8303671	14.88987	.5590002	4.223287
60	1.14	1	.02	.98	1	1	.12102	.5	.3	.1689599	9.119523	.1334959	4.300222
72	1.2	1	.01	.99	1	1	.0942667	.5	.3	.0512694	5.974811	.0420169	2.735759
												4.075406	21.02826

Yield per recruit (in + offshore): 25.10367

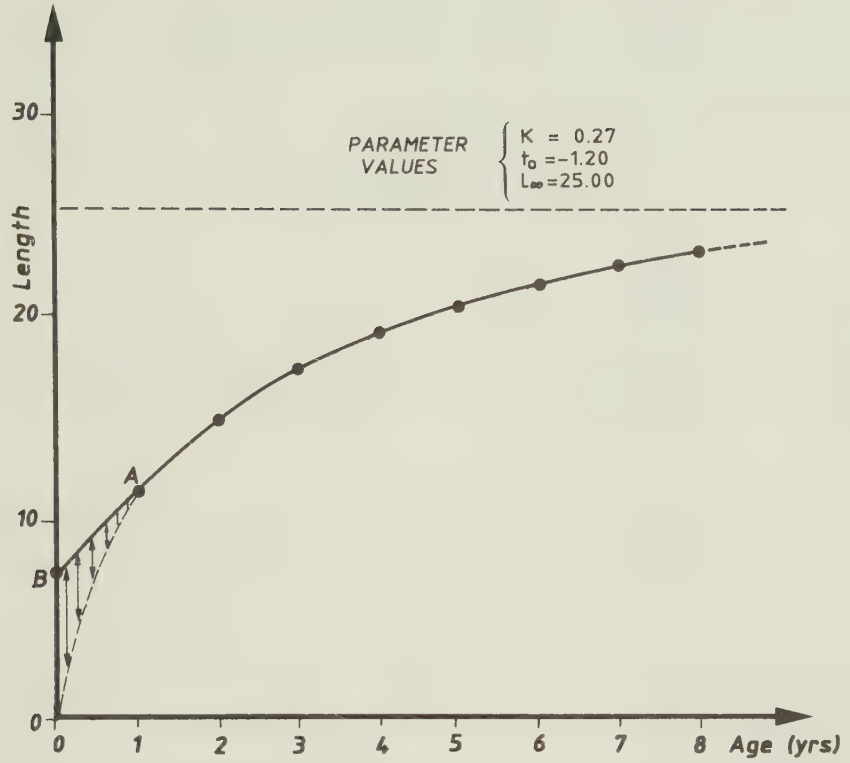

Figure 1 Bias in size at age for age classes 0-1 with von Bertalanffy growth curves where t_o <<0

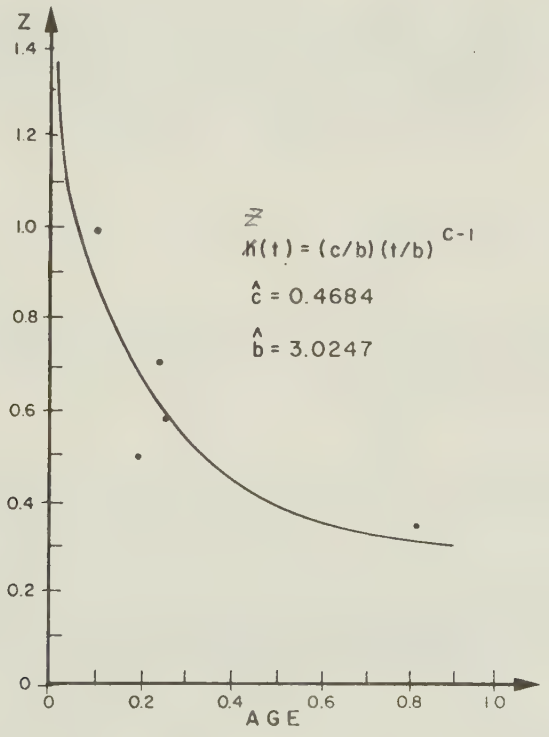

Figure 2 Weibull distribution fitted to the survival of larval herring (Clupea harengus) from the Georges Bank-Nantucket Shoals survey data (from Saila and Lough, 1981)

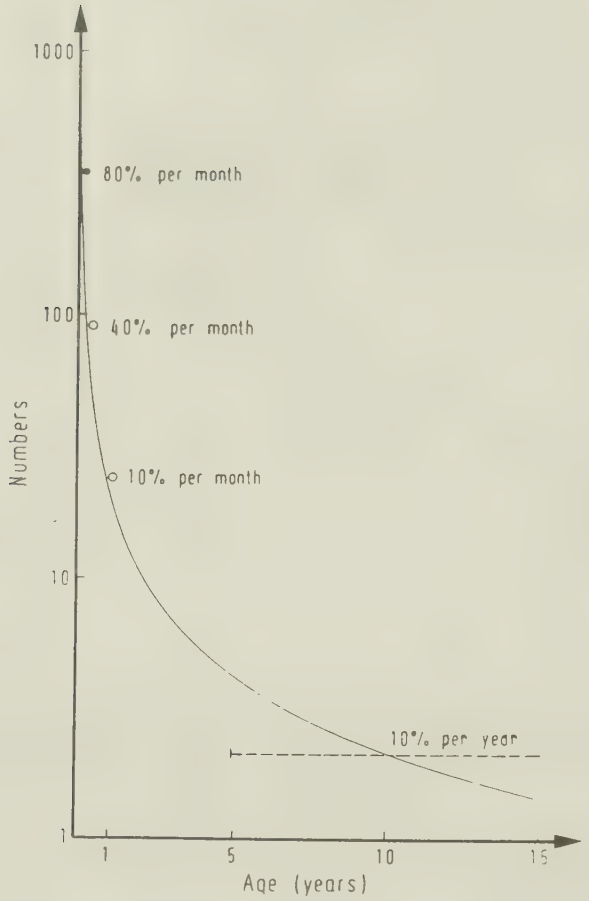

Figure 3a The trend in density-dependent mortality with age, assuming a larval mortality of 80%/month; the 0-group mortalities of 40%/month at 4 or 5 months and of 10%/month in the first winter, and the adult mortality of 10%/year are predicted (from Cushing, 1975)

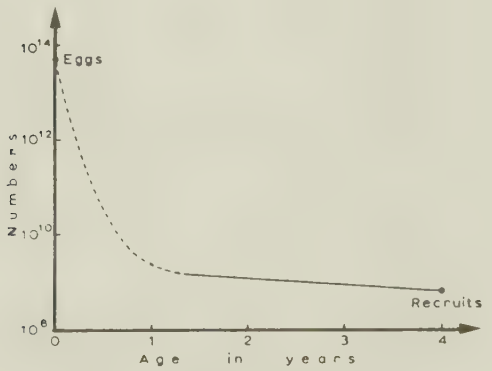

Figure 3b The mortality of Arctic cod during its first years of life (from Gulland, 1965)

APPENDIX/ANNEXE N

The Acoustic Survey Programme in Greek Waters

by

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1. INTRODUCTION

Plans for initiating acoustic surveys in the Greek fisheries research programme have existed since 1978; however, the implementation of such a project was only initiated in 1984 and the first acoustic survey was carried out in March 1987.

2. OBJECTIVES

There are four main objectives of our national acoustic survey programme:

(a) estimates of the abundance of pelagic fishery resources in Greek seas;

(b) study the horizontal and vertical distribution of these stocks;

(c) how these distributions change in time;

(d) determine what environmental factors trigger, influence and modify these distributions.

The project includes investigations on the main biological aspects of the populations under study, such as age and length compositions, growth rates, feeding, spawning, year class strengths, migration, recruitment and mortality rates.

The investigations are being focused on the following species, which together constitute the bulk of the commercially important pelagic ichthyofauna in the Aegean and Ionian Seas: sardine (Sardina pilchardus), sardinella (Sardinella aurita), anchovy (Engraulis encrasicolus), chab mackerel (Scomber japonicus colias), horse mackerel (Trachurus trachurus), Mediterranean horse mackerel (Trachurus mediterraneus) and bogue (Boops boops). However, first priority is given to the assessment of sardines and anchovies that together comprise a sizeable part of fisheries in Greece. Approximately one fifth of the national catch consists of these small pelagic fish.

3. MATERIAL AND METHODS

3.1 Vessel and Equipment

For the implementation of the Greek acoustic survey programme two fully equipped research vessels are used: AEGAION and PHILIA.

The two vessels have been designed and constructed in Greece. They are able to trawl down to a depth of 500 m as well as to fish in midwater, to be capable of collecting bottom samples by dredge or grab, to troll and also to be able to handle plankton sampling, hydrographic and acoustic equipment.

The acoustic equipment, however, is probably the principal scientific equipment aboard the research vessel PHILIA while the oceanographic instrumentation, for both physical and geological observations, is probably the principal scientific equipment aboard the R/V AEGAION.

The following acoustic equipments are installed on the R/V PHILIA: an ordinary FURUNO echosounder similar to those found on a commercial fishing vessel operating at 50 kHz, a SIMRAD SL 490 sonar operating at 49 kHz, two SIMRAD EK 400 scientific echosounders of 38 and 120 kHz respectively, a SIMRAD colour display unit slave either to the 38 or 120 kHz echosounder and a SCANMAR netsonde unit recording the trawlnet position. Also included is a SIMRAD LN Doppler speed log.

Echo-integration is carried out by a SIMRAD QD digital echo-integrator. This is used for quantification of the biomass in up to 10 different layers of the sea, of which 8 layers are referred to the surface and 2 layers are referred to the seabed. Results are presented as millimeter deflection for each layer, at each log interval. This factor millimeter deflection is

used for calculation of tons of fish per unit surface of sea (tons/n.mi^2). The QD integrator has its own data terminal communication and data presentation and a separate data logger output for interfacing to the ODAS (onboard data acquisition system).

The research vessel is also equipped with the necessary instruments to calibrate the echo-sounders for quantitative measurements. A complete dual beam acoustic unit, including a towed body, will also be shortly installed onboard the R/V PHILIA.

A similar acoustic instrumentation has been installed onboard the R/V AEGAION which is now being prepared to join PHILIA in our national acoustic surveys programme.

3.2 Onboard Data Acquisition and Processing System

For the acquisition and processing of the collected data, a system consisted of 3 HP Vectra computers has been installed onboard the vessel PHILIA. Besides hydroacoustic information and sampling data, the system is being expanded to log other data as well, such as navigational, fishing gear parameters, hydropgraphic and meteorological data. A block diagram of acoustic instrument designed connections with the computer system is shown in Figure 1.

3.3 Statistical Design

On the basis of the factors concerning mainly the distribution behaviour of the main pelagic fish under study, the bathymetric nature of the area, the expected domains of fish density centers, the geographical position of the area and the hydrographic conditions, we designed the following statistical subprogrammes:

A. FISH-ECHO (sounder data analysis)
B. FISH-SONA (sonar data analysis)
C. FISH-TRA (trawl sampling analysis)
D. FISH-CATCH (commercial catch analysis).

Thus, according to the distribution pattern of the main pelagic fish in terms of mean density and variance of fish occurrence, the Aegean Sea has been divided into 4 major strata (Figure 2). On the other hand, by taking into account the bathymetric nature of the area and the expected domains of fish density centers, each major stratum has been divided into minor strata; e.g., the major stratum 1 has been divided into three strata, namely 1.1, 1.2, and 1.3 respectively.

The sampling method, which is considered appropriate for acoustic surveys, is the method of line sample. Generally, in acoustic surveys, transects consist of offshore or inshore tracks or either zig zag or parallel design. We mostly used the parallel design transect method that is the most common one. It is maintly used in practice for convenience. Another advantage of the method is that it is easy to check whether survey operations have been conducted according to the plan.

Parallel transects with a spacing interval of 5 n mi have been considered as sufficiently large to cover the required domains of study adequately in our fist year acoustic sampling programme (Figure 3). However, spacing of the transect pattern will be reconsidered for the next cruises after taking into consideration the information collected so far on the distribution, and behaviour of the studied fish populations.

For handling and presentation of the echo-integrator and fish sampling data we have developed a data base programme on the basis of a commercial programme (d-BASE III plus) modified to satisfy the needs of our acoustic project. A data base subprogramme has been constructed for each group of incoming information.

4. SURVEY RESULTS

4.1 Acoustic Surveys

After a lot of experimental work in the use of the acoustic instruments and the fishing gears, which are used for the first time in Greece, PHILIA sailed in March 1987 for the first acoustic survey to the North Aegean Sea (major stratum 1). Since then one acoustic survey per season has been carried out in the major stratum 1.

In general four seasonal acoustic surveys are planned to be carried out annually. Additional surveys, however, may be conducted on the basis of information obtained during the first or probable the second year of implementation of the acoustic surveys programme.

4.2 Concurrent Trawling

Since all layers of the sea, except the surface, can be sampled with a trawl, the routine method of fishing chosen was trawling. Thus, pelagic trawling surveys were carried out concurrently with the main acoustic surveys aiming to supply the material needed for the verification of the counts attained at the main acoustic surveys, for species identification of the survey biomass, and the collection of biological information concerning the surveyed stocks.

From the variety of sample systems we have chosen the method of concurrent systematic sampling (Bazigos, 1981).

In this case a systematic sample of fishing stations is selected along the sample tracks of the main acoustic survey. Fishing experiments were conducted when concentration of fish was recorded by the echo-sounders.

Fish sampling from the R/V PHILIA is conducted by using a DANTRAWL semi-pelagic trawlnet of the dimensions given in Figure 4. The effective trawl opening was estimated to cover about 110 m^2.

4.3 Hydrography

Temperature, salinity and disolved oxygen measurements at standard depths down to 200 m were observed by using a SEABIRD CTD profiler. the acquisition of the data from the CTD by the Onboard Data Acquisition and Processing System is carried out automatically.

4.4 Estimation Process

The echo-integrator values were recorded for each nautical mile sailed (EDSU = 1 n mi) and average values for each 5 n mi were calculated. Provided that M is proportional to the average fish density d (Forbes and Nakken, 1972), the fish biomass can be estimated from the formula d = C x M, where M = the mean total integrator outup and C= fish coefficient t/n mi/mmd.

During the first phase of our acoustic surveys programme we have used the coefficient C estimated by Burczynski and Azzali (1977) for sardines and anchovies. Such estimates however are valid for certain species under a certain system of echo-sounders settings. Therefore it is necessary that C should be recalculated for the set of equipment on board the R/V PHILIA. This is planned to take place after the completion of the appropriate software development. Meanwhile on the base of mmd measurements obtained during the July 1987 and October 1987 surveys and approximate pattern of fishery resources distribution in the major stratum 1 is given in Figure 5. Further analysis of data is under study.

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Forbes and Nakken, O., 1972. Manual of methods for fisheries resources and apraisal. Part 2. The use of acoustic instruments for fish detection and abundance estimation. FAO.Man.Fis. Sci., (5):138 pp.

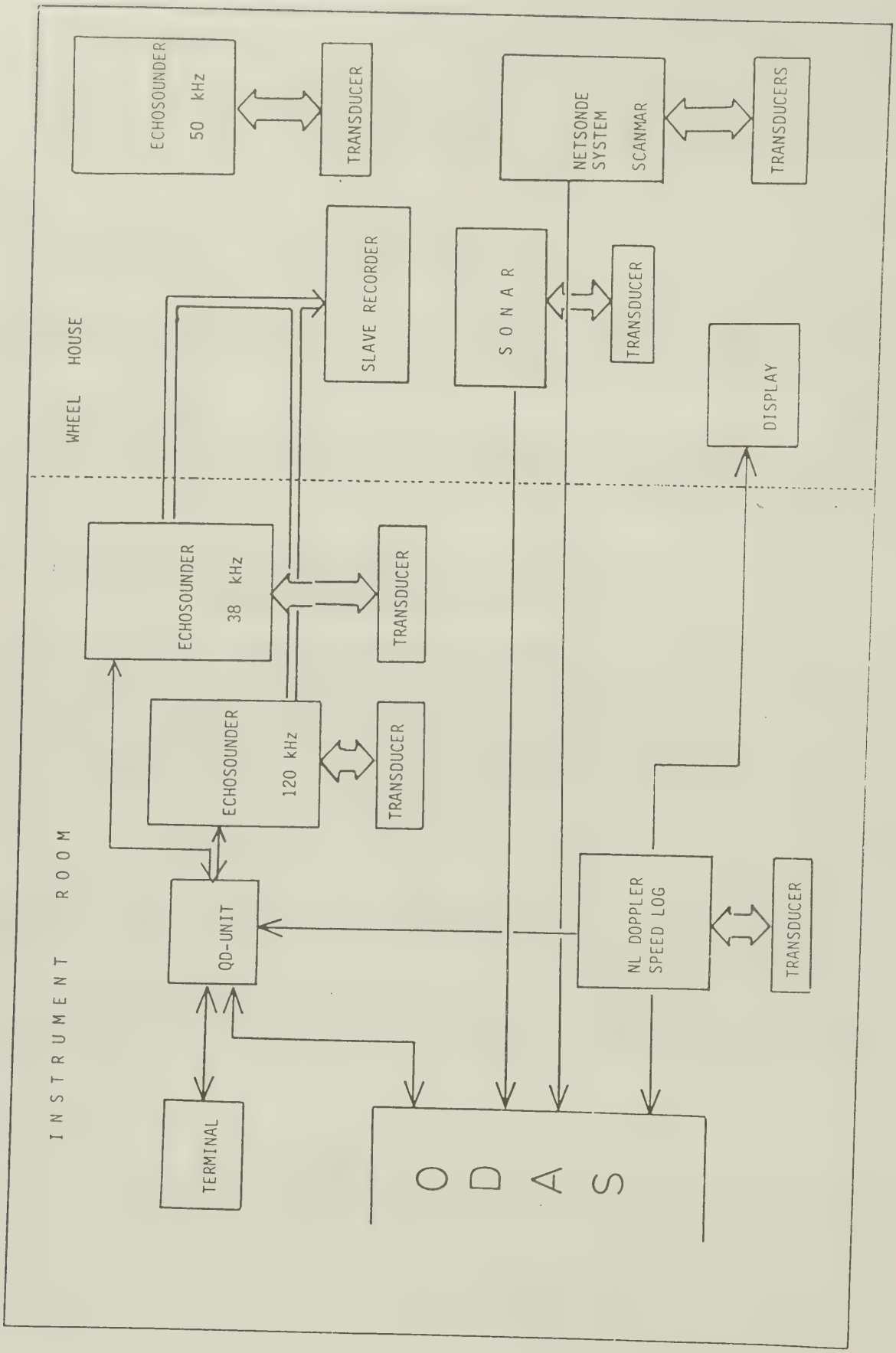

Figure 1 Acoustic instruments on the R/V PHILIA

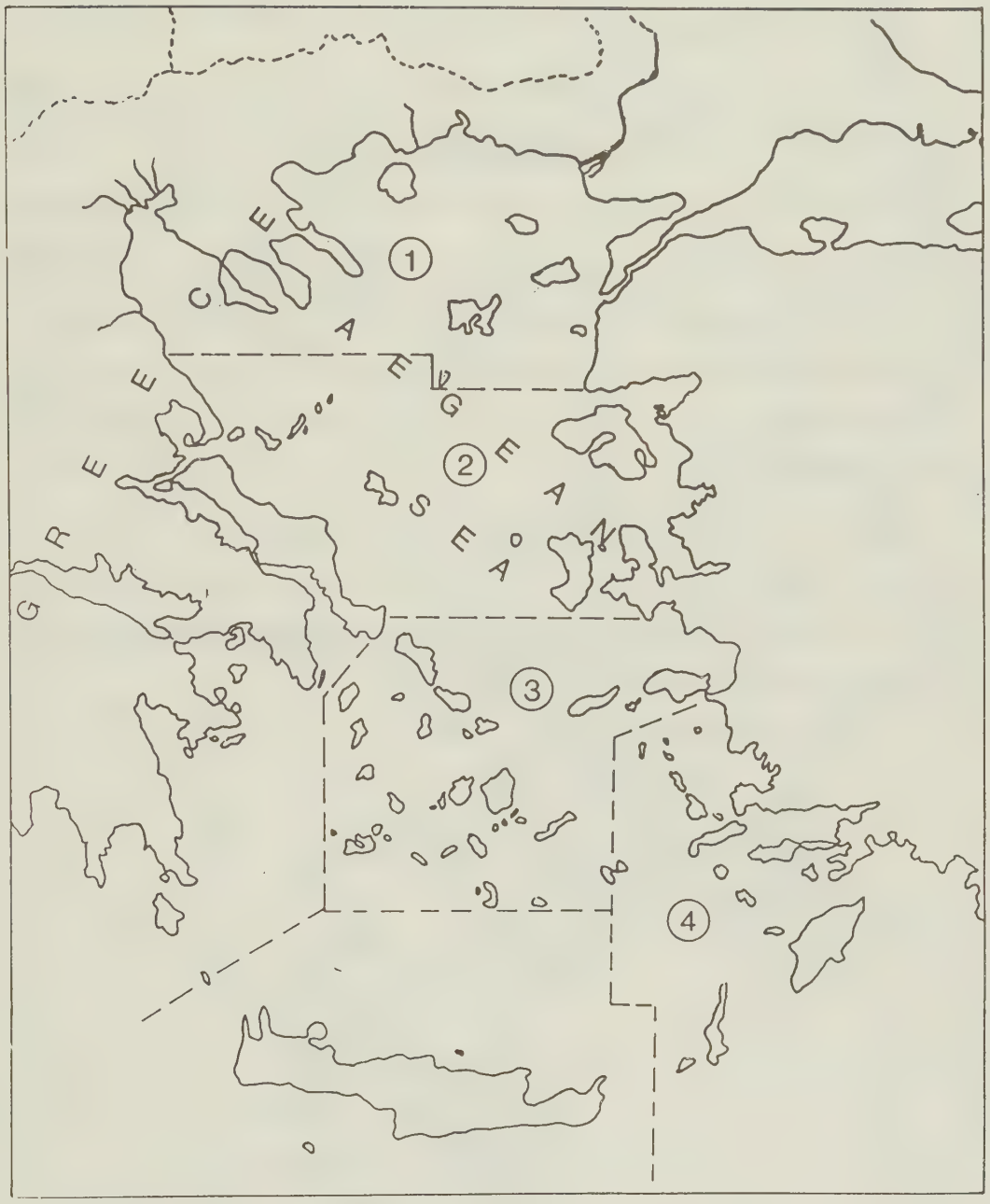

Figure 2 Stratification of the Aegean Sea into four major strata

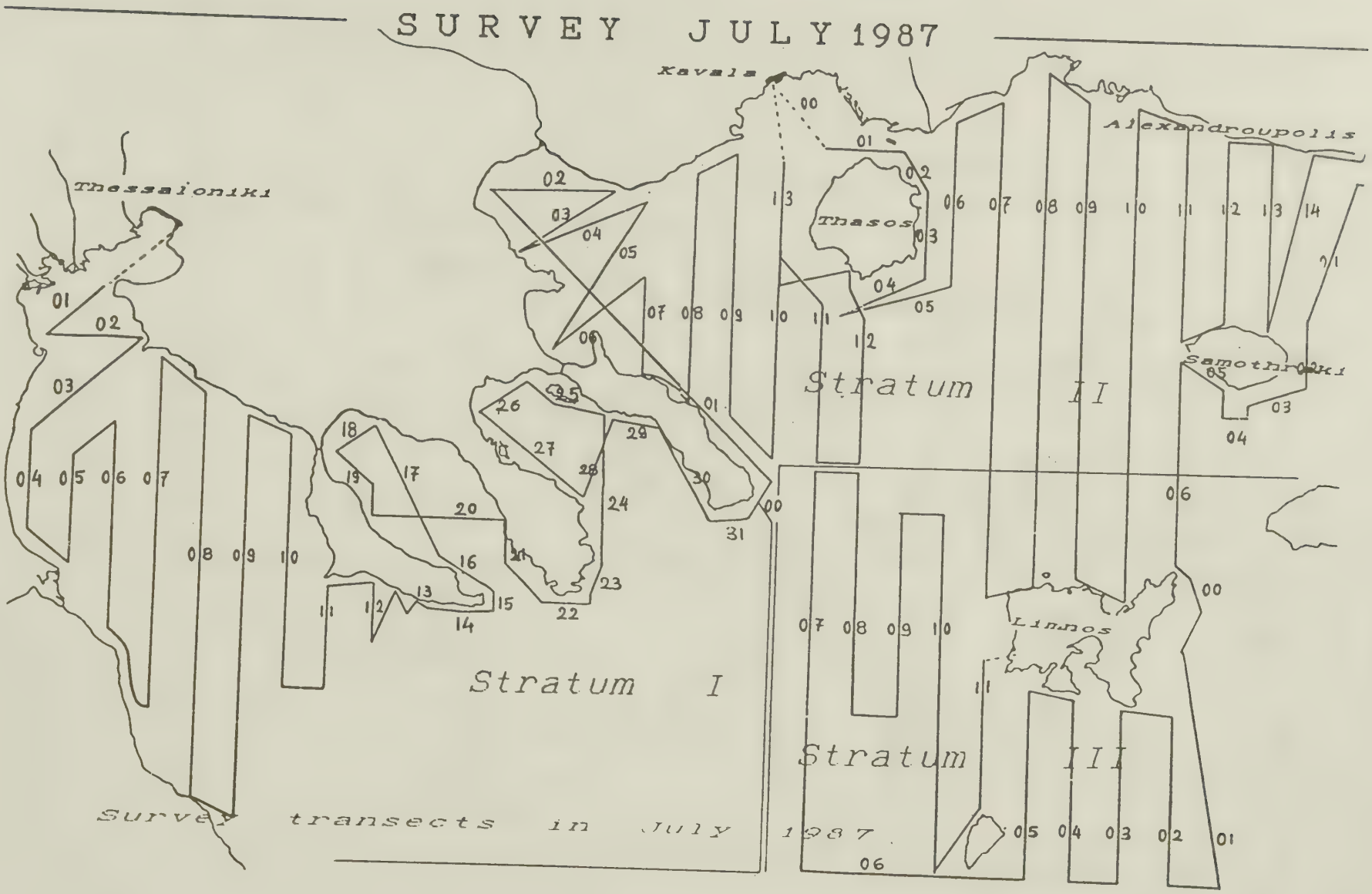

Figure 3 Aegean Sea - Northern part - Survey July 1987
Survey transects in July 1987

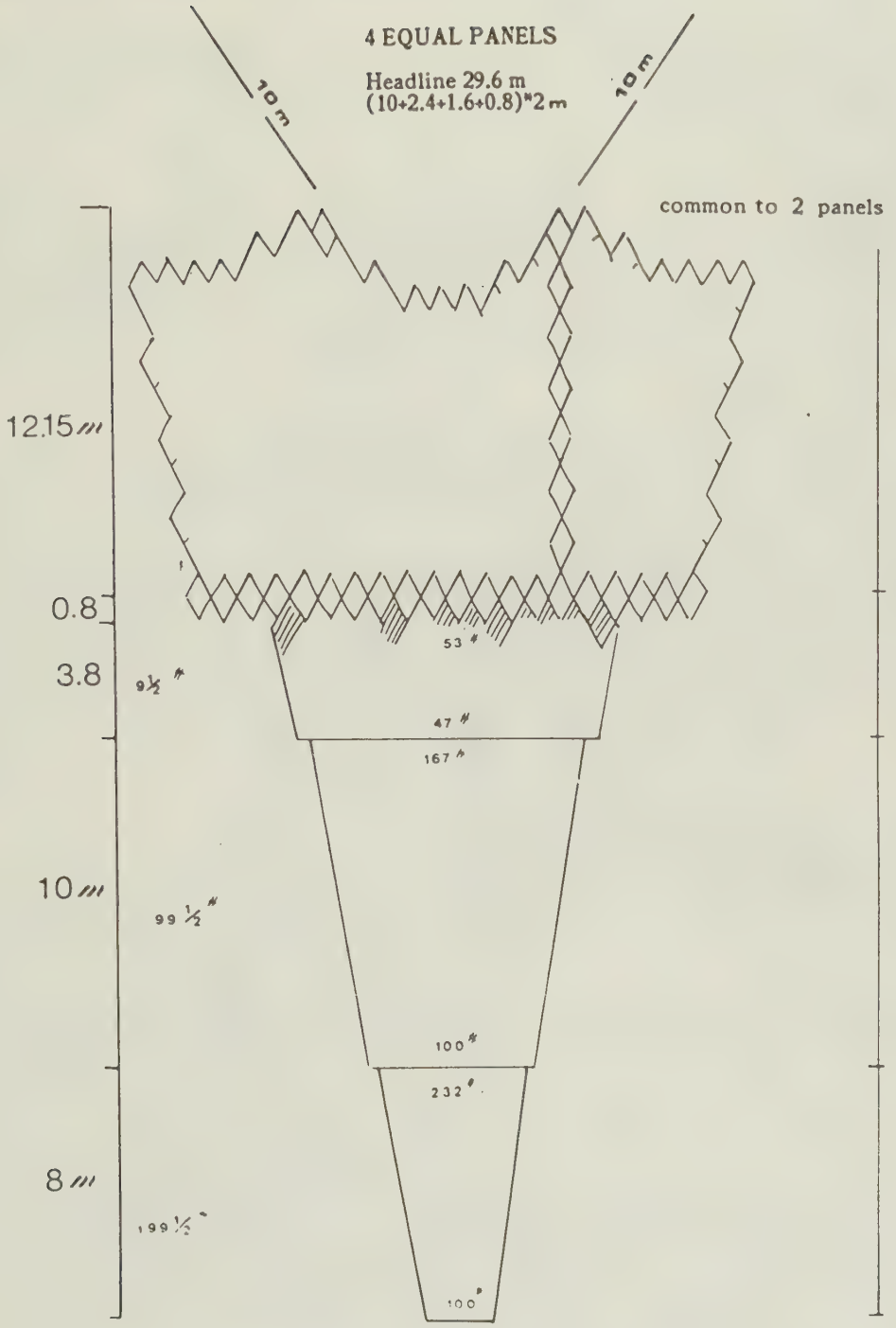

Figure 4 Semi-pelagic trawlnet used for sampling

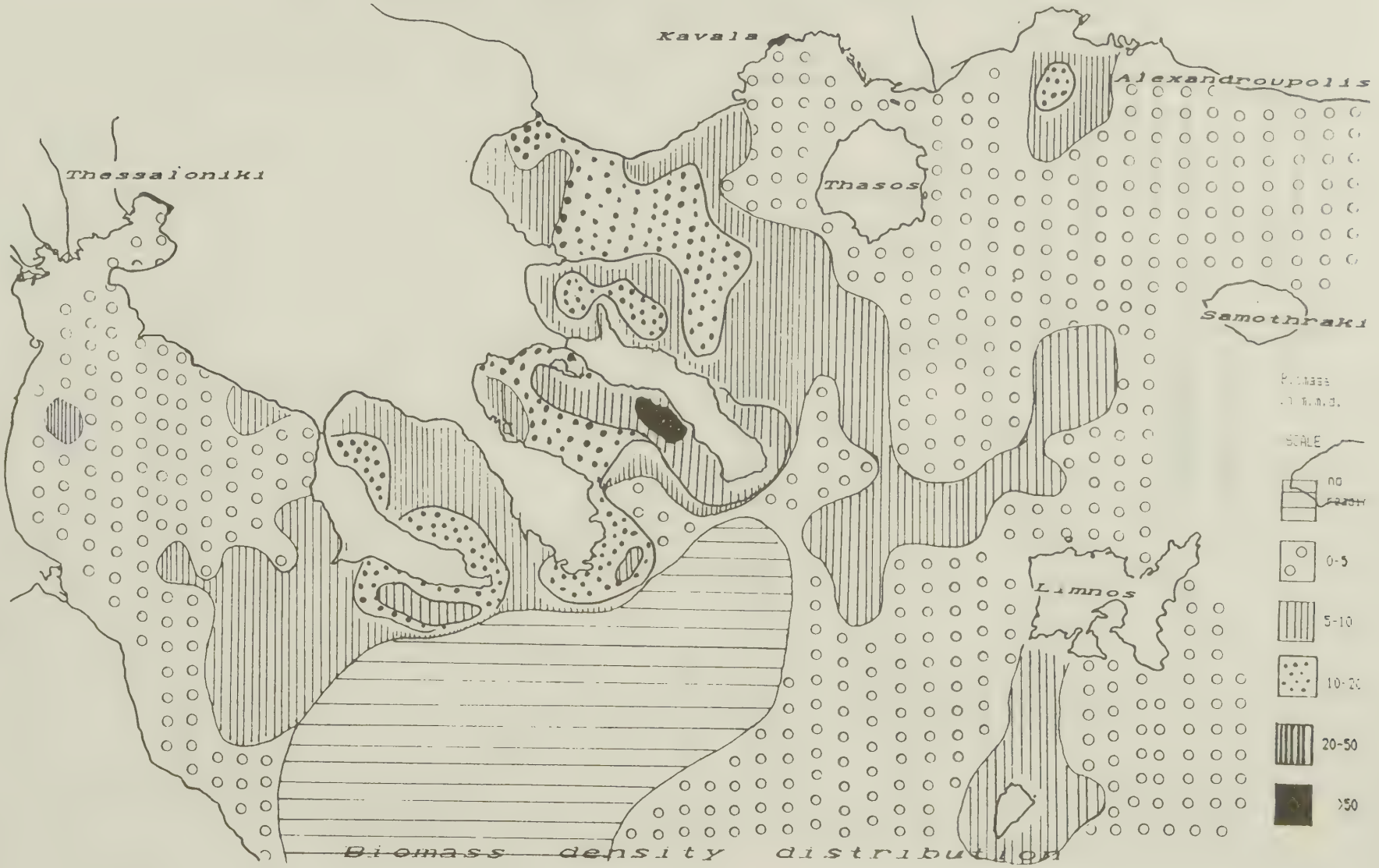

Figure 5 Aegean Sea - Northern part - Survey July 1987
Biomass density distribution

APPENDIX/ANNEXE O

Fishery and Biology of the Swordfish Xiphias gladius, L., 1758 in Greek Waters

by

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This study was realized with financial aid from the Commission of the European Communities[1/]

ABSTRACT

The results of investigations on the swordfish fishery in the Greek seas from July 1986 to September 1987 are presented. A total of 334 boats out of 486 fishing for large pelagics, were involved in this fishery with a total annual catch of 1 500 tons. Fishing for swordfish is carried out throughout most of the year in almost all Greek seas. The greatest annual catch per vessel of 13.2 tons was registered in Kalymnos, which also recorded the highest percentage of individuals longer than 105 cm. In Kythnos the catch mainly consisted of individuals smaller than 105 cm. In general the mean weight per individual caught in Kalymnos was the highest in all Greek ports. Observations on swordfish maturation show that the most active spawning occurs during June to July. In most cases, males reach sexual maturity at the end of their second year while females reach sexual maturity at the end of their third year.

1. INTRODUCTION

Among all large Scombroidei exploited in Greece, the swordfish (Xiphias gladius) fishery is the most important. Fishing for swordfish started in 1969 by a group of fishermen from the island of Kalymnos, who set up the first long-line, copying that used by Sicilian fishermen. Although a recent activity, it is already widespread and expanding all the time to involve a progressively increasing number of operators and boats.

Only fragmentary information on this activity exist so far, obtained mainly from official statistics, which, however, are unable to give a satisfactory picture of the situation. Therefore, it was considered necessary to set up a project plan with the following objectives: (a) appraisal of fishing effort and the corresponding catch, (b) distribution of the swordfish stocks, size composition and maturity process.

The aim of this investigation is to contribute to the management of the swordfish stocks in the Mediterranean with the cooperation of all countries involved.

This programme of collaboration between the Istituto Comunale di Biologia Marina in Nardo, the Fisheries Division of the Greek Ministry of Agriculture and the Biology Department of the University of Crete, got underway precisely in the light of this consideration, hoping that Italy and Greece would certainly be able to produce a set of basic data for swordfish fisheries in the Aegean and Ionian Seas in order to set up a common strategy for this fishery.

2. MATERIALS AND METHODS

Data on number of fishing vessels, the corresponding catch, and location of the fishing grounds were obtained through direct investigations at each fish port during the years 1986-87. Estimates of the total catch were obtained through direct investigations and interviews with fishermen.

1/ "This study does not necessarily reflect the opinion of the Commission of European Communities and does not prejudice their future attitude in this field"
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Total fishing effort (f) was calculated using the following formula:

f = No. of hooks operated daily x No. of fishing days/1 000

Fork length (from the tip of lower jaw to the fork of caudal fin) was measured in 3 045 swordfish. The sex and stage of maturity was determined from the gonads of 1 393 fish according to the Holden and Raitt (1974) scale. The gonadosomatic index was calculated for 219 fish from the eviscerated animal weight by the use of the formula:

G.I. = Gonad weight x 100/Eviscerated animal weight

Pieces taken from 69 gonads were fixed either in Bouin fluid or in 10% formaldehyde solution. Sections of gonads (5-7 μ thick) were stained either with Hematoxylin - Eosin or with Azan - Mallory.

3. RESULTS

3.1 Fish Ports

The investigation showed that a total of 486 boats from 78 ports, allocated in 15 major areas, fished for large pelagic fish in Greece during 1986-87. The number of boats, grouped by size, horse power, main locality and kind of fishery, is shown in Table 1.

Accurate grouping of the total number of boats, in accordance with the target species to which each group directed its fishing activity, showed that 334 boats out of 486, viz. 68.2%, were involved in the swordfish fishery.

Table 1 shows that Chalkidiki is the area with the greatest number of boats, followed in turn by the fleet of the Sporades islands, the Saronikos Gulf, the Dodecanese islands and the coasts of Peloponnesus. Among these major areas the highest number of boats over 14 meters in length worked in the Dodecanese area, while the highest number of boats of less than 9 meters worked in the vicinity of Sporades islands.

Concerning the engine power of the fishing boats, Thessalonike is evidently the area of the highest engine power per boat, however, vessels from this area direct their activities mainly to the tuna fishery. Also the same comment applies to some other groups of boats with relatively high engine power, such as those fishing the north coasts of Greece. Among the boats fishing for swordfish, the highest engine power per vessel is mainly represented by the Cretan and Dodecanese fleets. This is obviously due to boats from these latter areas extending their activities much further from port.

3.2 Fishing Grounds

Fishing for swordfish occurs practically throughout the whole Aegean Sea except for the most northerly areas (Figure 1). Swordfish fishing is also carried out in the Ionian Sea and particularly in the area extending from a few miles to 10-20 miles off the west coasts of the islands and the mainland. The fishing boats of Crete operate mainly in the Cretan sea from the island of Kythira in the west, to the Dodecanese islands in the east, and to the Cyclades islands in the north. Moreover some Cretan boats carry out excursions of a few days, mainly in spring and summer, both in the Ionian and Levant Seas, reaching as far as Cyprus. The Dodecanese fishing boats on the other hand, concentrate their activities mainly around the Dodecanese Islands but often they also reach as far as Cyprus, particularly during spring. The Cyclades fishing boats mainly carry out their activities around the islands of this archipelago.

3.3 Fishing Period

In general, fishing for swordfish in Greece is carried out throughout most of the year, particularly in the southern regions, with the most active period, May-September (Table 2). During the rest of the year fishing activity is reduced, both in terms of the number of vessels and number of fishing days per boat, due to the worsening meteorological conditions.

Another reason for the concentration of fishing activities during summer, is that most of the boats involved in the swordfish fishery work as trawlers during the rest of the year.

3.4 Systems of Capture

Swordfish fishing in Greece is exclusively carried out by drifting longline, copied from that of Sicilian fishermen. It is made up of a single nylon thread about 35-40 km long, from which a thousand sidelines lead off at intervals of about 35 m. They are 4-5 m long and made of the same

monofilament nylon and armed with hook numbers 1 and 2. At 3-4 km intervals marker buoys are attached to the longline. These consist of poles with pieces of black plastic attached on the open like flags, for ease of visibility together wtih radar reflectors.

In some Ionian Sea ports (Parga) and in Crete (Chania), where some boats direct their fishing effort mainly to young fish, the equipment is modified and presents the same features as the gear for albacore (Thunnus alalunga),

Setting of longlines begins at about 17.00 h and hauling at about 05.00 h the next day. The bait used is generally Scomber scombrus L. or Scomber japonicus colias GM. However, Sardina pilchardus Walb or Sardinella aurita Val are also used in the case of fishing young fish.

3.5 Total Catch

In 1986 the total landings of Xiphias gladius in Greece reached 1 530 tons (Table 3) putting Greece second after Italy and before Spain, among Mediterranean countries involved in the swordfish fishery. The Dodecanese area seems to be the most productive one among the 15 major areas into which the fishing grounds in the Greek seas have been arbitrarily divided for statistical reasons. Nearly half the total swordfish catch in Greece in 1986 came from this area where the catch per boat reached 13.2 tons compared with the lowest of 0.9 tons boat for the east Aegean islands and the overall average of 4.6 tons/boat for all Greek seas (Table 3).

3.6 Fishing Effort and cpue

Among the 15 major areas, the ports of Kalymnos in the Dodecanese area, Chania in Crete, and Kythnos in the Cyclades islands, were selected as pilot ports for collecting precise effort and corresponding catch.

Table 4 shows that the greatest effort both in 1986 and 1987 was by the Kalymnos fleet. On average, it was 12 times that of Chania and 80 times that of Kythnos.

Considering the parameters on which effort depends, the variable that played an important role was that related to the size of the boats in conjunction with the engine power. The larger the boat the longer the voyages, increasing therefore the fishing effort of the fleets consisted of larger boats. Also other factors such as the tradition and experience of the fishermen influenced the outcome in favour of Kalymnos.

Cpue in biomass of swordfish registered relatively high values (Table 4). In both Kalymnos and Chania in 1986 the cpue was higher than that registered in the Gulf of Taranto (De Metrio et al., 1987) or in the South Adriatic (Marano, 1985). A slight drop, however, of cpue in biomass from 1986 to 1987 in the prementioned areas, is probably due to the yearly fluctuations observed also in other regions of the Mediterranean (De Metrio and Megalofonou, 1987).

As far as the cpue in number of individuals is concerned, the much higher value of this parameter in Kythnos is obviously related to the much lower value of the mean weight per individual caught in this area (Table 4).

The situation of Kythnos, however, is remarkable in that although fishing effort was directed to small individuals, cpue in biomass registered in 1987 was higher than that in other ports (Table 4). This was probably the result of high recruitment of a particularly successful year class.

3.7 Size Distribution

The fork lengths were measured in 1986 of 301 and 780 swordfish caught in the sea areas of Chania, and Kalymnos respectively. As shown in Figure 2a most of the catch, namely 50.9% in Chania and 53.2% in Kalymnos, was made up of individuals ranging in length from 105 to 135 cm while the percentage of individuals longer than 135 cm were 32.9% and 38.1% in Chania and Kalymnos respectively. During the same year a relatively small percentage (16.2%) in Chania were less than 105 cm and only 8.7% in Kalymnos.

In 1987 the fork length of 642, 1 100 and 223 swordfish were measured in the catches from the sea areas of Chania, Kalymnos and Kythnos correspondingly. The size distribution of those individuals was notably different between the areas (Figure 2b). In particular, most of the catch (73.0%) in Kalymnos was made up of individuals longer than 135 cm, while only 10.8% of the individuals caught in Kythnos and 33.9% in Chania were longer than 135 cm. On the contrary individuals of lengths less than 105 cm comprised most of the catch (66.6%) in Kythnos and only 0.6% in Kalymnos and 32.0% in Chania. Middle sized fish (105-135 cm), on the other hand, in the areas under consideration comprised 26.4%, 34.1% and 22.6% of the catch in Kalymnos, Chania and Kythnos respectively.

Considering the size of swordfish caught in the course of a year it has been noticed that the number of relatively smaller fish in the catch of winter and early spring was higher than that in the rest of the year, however, the available data so far do not make it clear whether this was due to a higher concentration of young fish during winter and early spring, or to the fact that the fishing boats usually work inshore during that period of the year.

The difference in the size distribution of swordfish between the samples from the pilot ports could be better realized, however, if we compare the mean weight per individual caught over the course of a year. Such a comparison suggests that in general, individuals unloaded in the port of Kalymnos were the largest of those in the pilot ports (Figure 3).

3.8 Length-Weight Relationship

The length-weight relationship for 960 eviscerated individuals with sword sawn off approximately at the extremity of the lower jaw and FL ranged between 90 and 206 cm was calculated giving the following equation for the sexes combined.

$$W = 4.751 \times 10^{-6} \times L^{3.171}$$

where W is expressed in kilograms and L in centimetres.

3.9 Reproduction Biology

3.9.1 Sex ratio

A total of 1 323 swordfish were examined for studying the progressive development of gonad maturity and the sex ratio during the years 1986 and 1987.

The sex ratio in the catch of Chania in 1986 showed a slight margin of males over females (54.8%) during the fishing season. In 1987, however, the sex ratio of samples from the same port was nearly 1:1, while in samples from Kythnos females were slightly over males.

As regards size in relation to sex, a prevalence (75.4%) of females with FL over 150 cm was noticed in samples from Chania during 1986.

3.9.2 Maturity

State of gonads was recorded from samples collected in Chania during 1986 and 1987 and in Kythnos during 1987. Females with mature gonads (stage IV) were observed in relatively small percentages during June and July (Table 5) whereas no mature female was observed during the rest of the year. Concerning the maturity process of males, mature males (stage IV) were much more abundant than mature females and distributed over a longer period, namely from June to September, with a progressively decreasing percentage from month to month (Table 5). Though only small percentages of mature and spent females were found during the period of the investigation it may be concluded that spawning of swordfish probably occurs during summer time. On the other hand, regarding the higher percentages of mature males than females observed during the same period, it can be concluded that this is probably because: (a) most individuals examined were less than 135 cm long (Figure 3), and (b) males reach first sexual maturity earlier than females (Megalofonou *et al.*, 1985 and Megalofonou, De Metrio and Lenti, 1987).

Correlating the stage of maturity with the size of individual, it was observed that 20% of males with FL 82 to 105 cm had reached sexual maturity, whereas in females of the same dimensions the gonads were still in stages I or II (Table 6). In individuals with FL between 106 and 135 cm, the percentage of mature males was 67.2% while only 8.6% of females in the same length range had mature or emptied gonads. Regarding individuals longer than 135 cm the percentage of mature or spent males was still higher than for the females (86.6% and 57.1% respectively).

On the basis of the above data and according to De Metrio and Megalofonou (1987) females reach sexual maturity at the end of the second year while most of them are mature at the end of their third year.

3.9.3 Gonado-somatic index

The gonado-somatic index of 219 individuals in relation to the maturity process, calculated on samples caught in Chania during 1986, is shown in Figure 4. The increase from stage III to IV is more rapid for females than for males, while the rapid decrease of the gonado-somatic index from stage IV to V is obviously due to spawning. Concerning average values of the gonado-somatic index in the course of a year it was found that the highest value for both sexes was observed in July, namely 1.90 for females and 0.29 for males.

4. DISCUSSION

Although the fishery for large scombroids is a relatively new activity in Greece, a fleet of about 500 fishing boats engaged in this fishery is noteworthy. However, despite of the numerous fishing boats the effort is greatly affected due to the small size of most of them, a fact that restrains their potential for long trips. Only a few boats with autonomy of 20-30 days are able to carry out trips in more distant seas, for example the Levant Sea, where catches are much higher. Probably this is the reason why the Dodecanese area with 4 ports and 54 boats has the highest average yearly catch of swordfish per boat.

As it was stated earlier, the fishing period for swordfish normally covers the whole year, however, the main activity is concentrated in a well defined period namely from late spring to autumn, reaching its climax in the months of July and August. This is for two main reasons:

(a) Most of the boats are involved in multiple activities of which trawl-fishing is the most important, so that from May to September, when this kind of fishing is interrupted, many fishermen turn their attention to swordfish.

(b) In the late autumn and winter months the meteorological conditions become prohibitive even for big boats.

From data on the three pilot ports it is easy to see that Kalymnos is the port with the highest percentage of large individuals (longer than 105 cm), whereas Kythnos, on the contrary, has the highest percentage of small ones (smaller than 105 cm).

Considering the reasons for such a size distribution of swordfish it is easy to deduce that the greater number of small individuals in Kythnos is due to the constant actviity near the coasts of the Cyclades isles while the capture of relatively bigger fish in Kalymnos is due to fishing off the coasts of the Dodecanese isles. Chania, on the other hand, represents an intermediate situation where fishing is carried out both in areas close to the coasts and at distances of 15-30 miles.

From the study of the distribution of sizes during the course of the fishing period it also becomes clear that quite high numbers of young fish are caught mainly in early spring and late autumn, either occasionally during fishing for adults, or, as occurs in some localities, during other fishing activities, such as for albacore. This problem, which is not exclusively Greek but also concerns the Italian swordfish fishery (De Metrio and Megalofonou, 1987), has given rise to the decision of the Greek Ministry of Agriculture to issue a decree prohibiting fishing for swordfish in Greek territorial waters from the 1st October to the 31st January.

Actually, this decision seems to be not the most effective action for a number of reasons. Firstly the decree does not apply in waters beginning six miles from the coast and therefore cannot be extended to fishermen from other countries, such as Italy, which operate in international waters close to the Greek territorial seas. Secondly the decree applies indiscriminately to both fishermen who catch young fish purposefully and those who catch them accidentally. Thirdly, from February on, there are still elevated numbers of young fish in coastal waters which are not protected at all. The authors are of the opinion that a more suitable measure at least for the time being, would be to fix either a minimm size of fish or a minimum sizse of hook on the longline.

In any case it would be desirable for countries which share common resources, to come to an international agreement regarding the protection of large scombroid fish.

Regarding our findings on the reproduction biology of swordfish we can point out the following:

(a) The presence of spent fish during the period from June to September suggests that swordfish have a rather extensive spawning period. This would explain the sporadic findings of various sizes of young individuals at various times of the year. It has also been observed that the swordfish ovary at stage V is still very large. Its walls are very thick and hard to touch, so much so that only by a certain pressure by the fingers it is possible to feel the presence of a central cavity without mature elements. Histological examinations made it possible to demonstrate that, after spawning, the reticular periplast of the lamellae still contains high number of oocytes of various size from 11.7 μ to 719.5 μ with an average of 72.1 μ in the various developmental phases. These observations would lead to the conclusion that swordfish, in the course of its reproductive period, may deposit several times.

(b) The males are more precocious than females and, at the end of the first year, their testicles still show complete spermatogenesis. The examination of one year old males with partly mature but not emptied gonads suggests that the germinal products are probably reabsorbed in young fish. So, the first reproductive period should coincide with the end of their second year. Instead, for females, such a situation occurs at the end of their third year even if some may already have mature ovaries at the end of their second year.

(c) The presence of swordfish individuals with mature gonads, together with the catch of young fish, in all the ports considered, from the northernmost stretches of the Ionian Sea to the easternmost parts of the Aegean suggests that the reproduction area of swordfish in the Mediterranean is rather larger than was formerly believed.

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Table 1

Division of vessels according to the size and engine power, in groups for each major region or fishing port

Major region or fishing port	Number of boats	LENGTH (m)			ENGINE POWER (HP)			
		9	9.1-14	14	MIN	MAX	MED	SUM
DODECANESE	54	6	16	29	20	450	171.8	9277
CYCLADES	29	5	21	2	11	190	72.5	2103
CRETE	39	8	22	2	36	425	207.6	8096
IONIAN SEA ISLANDS	27	6	14	1	15	250	98.4	2657
EPIRUS	20	14	5	1	10	180	60.6	1213
PELOPONNESUS	45	15	25	4	5	370	104.3	4694
SPORADES	65	42	21	2	10	150	51.6	3354
MAGNISIA	11	/	3	8	100	240	168.0	1848
KAVALA	33	19	15	3	6	320	100.3	3310
RODOPE	4	/	4	/	100	135	125.2	501
THESSALONIKE	5	/	/	5	280	525	340.0	1700
CHALKIDIKI	80	17	35	7	3	270	152.0	12160
EVIA	7	3	4	/	32	116	79.0	553
SARONIKOS GULF	56	3	27	3	30	124	68.6	3842
ISOLE EGEO ORIENTALE	11	4	7	/	25	120	79.8	878
TOTAL	486	142	215	67	3	525	115.6	56186

Table 2

Monthly distribution of vessels fishing for Xiphias gladius during the years 1986-87

Major region	TOTAL	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
DODECANESE	54	-	3	26	28	39	50	52	40	34	24	2	1
CYCLADES	29	-	12	16	23	26	15	15	15	14	11	-	-
CRETE	39	20	21	25	30	34	36	34	34	31	29	24	19
IONIAN SEA ISLANDS	27	12	12	14	14	14	14	13	13	18	24	12	12
EPIRUS	20	12	12	11	11	13	14	13	12	16	16	15	14
PELOPONESUS	45	21	21	25	27	31	33	35	36	37	33	23	23
SPORADES	11	-	-	-	-	-	-	4	9	8	5	3	-
MAGNISIA	11	-	-	11	11	11	11	11	11	11	10	-	-
KAVALA	5	-	-	-	-	-	1	3	3	5	5	2	-
CHALKIDIKI	24	-	-	-	-	24	24	24	24	24	-	-	-
EVIA	2	-	-	-	-	-	2	2	2	2	-	-	-
SARONIKOS GULF	56	-	-	-	-	29	28	29	29	29	29	14	14
ISLANDS OF EAST AEGEAN SEA	11	-	-	-	1	2	4	4	5	6	4	4	4
TOTAL	334	65	81	128	145	223	232	239	233	235	190	99	87

Table 3

Total swordfish catches per region and average annual catch per boat in 1986

Major region	Number of boats	Total Catch (tons)	Average annual catch per boat (tons)
CRETE	39	140.40	3.6
CYCLADES	29	43.50	1.5
IONIAN SEA ISLANDS	27	67.50	2.5
EPIRUS	20	46.00	2.3
SARONIKOS GULF	56	117.60	2.1
MAGNISIA	11	67.10	6.1
ISLANDS OF EAST AEGEAN	11	10.34	0.9
EVIA	2	2.00	1.0
DODECANESE	54	712.80	13.2
PELOPONNESUS	45	207.00	4.6
SPORADES	11	12.10	1.1
CHALKIDIKI	24	103.20	4.3
KAVALA	5	-	-
TOTAL	334	1529.54	4.579

Table 4

Summarized catch and effort data in the pilot ports in 1986 and 1987

DATA	KALYMNOS		CHANIA		KYTHNOS	
	1986	1987	1986	1987	1986	1987
Number of boats	27	30	11	12		9
Work days	779	2004	153	179		87
Mean number of hooks	1118	1148	801	877		329
Number of individuals	4343	6209	756	998		361
Weight of catch (kg)	141693.5	217689	17457	17972	No	3920
Mean weight per individual (kg)	32.6	35.1	23.1	18	Data	10.8
Fishing Effort (x 1000 hooks)	870.8	2300.1	122.5	156.9		28.6
CPUE (Number of indiv.)	5	2.7	6.2	6.4		12.6
CPUE (Weight)	162.7	94.6	142.5	114.5		136.9

Table 5

Frequency of gonad maturity stages during the period of June to September in samples of swordfish from Chania and Kythnos combined for the years 1986 and 1987

Maturity Stages	JUNE				JULY				AUGUST				SEPTEMBER			
	M		F		M		F		M		F		M		F	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1	41	18.5	60	29.4	75	39.9	73	46.8	23	32.4	26	37.1	23	32.4	26	37.1
2	30	13.5	56	27.5	23	12.2	33	21.2	12	16.9	17	24.3	12	16.9	17	24.3
3	48	21.6	38	18.6	29	15.4	37	23.7	25	35.2	25	35.7	25	35.2	25	35.7
4	80	36.0	33	16.1	39	20.8	5	3.2	6	8.4	-	-	6	8.4	-	-
5	23	10.4	17	8.4	22	11.7	8	5.1	5	7.1	2	2.9	5	7.1	2	2.9
Total	222	100	204	100	188	100	156	100	71	100	70	100	71	100	70	100

Table 6

Frequency of gonad maturity stages in relation to the length of swordfish

Maturity stages	Fork Length in cm					
	82 - 105		106 - 135		136 - 207	
	M	F	M	F	M	F
1	20	47.4	4.9	11.4	0	0
2	28	52.6	9.8	42.9	6.7	8.2
3	32	0	18.1	37.1	6.7	34.7
4	8	0	39.3	5.7	56.6	26.5
5	12	0	27.9	2.9	30.0	30.6

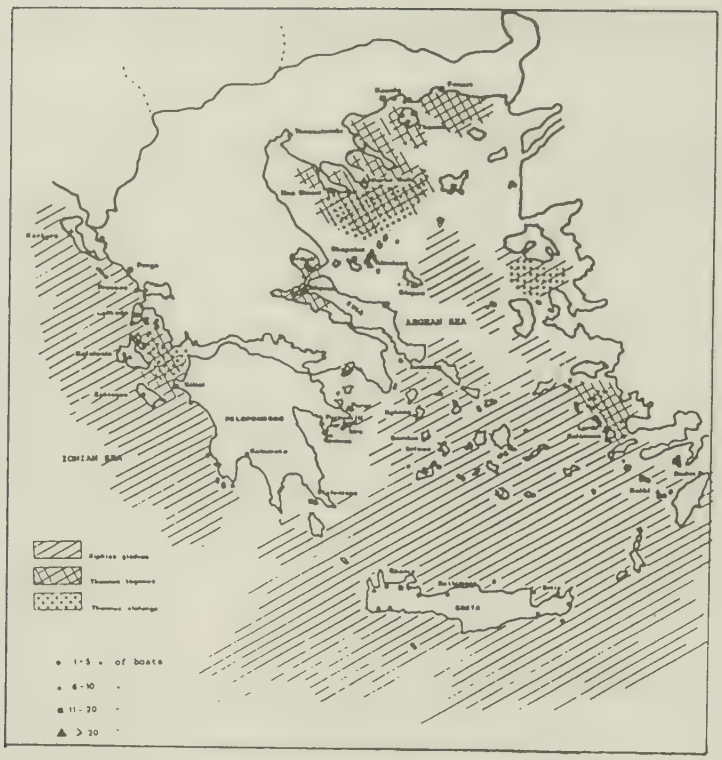

Figure 1 Distribution of fishing activities for large scombroidei in the Greeck seas

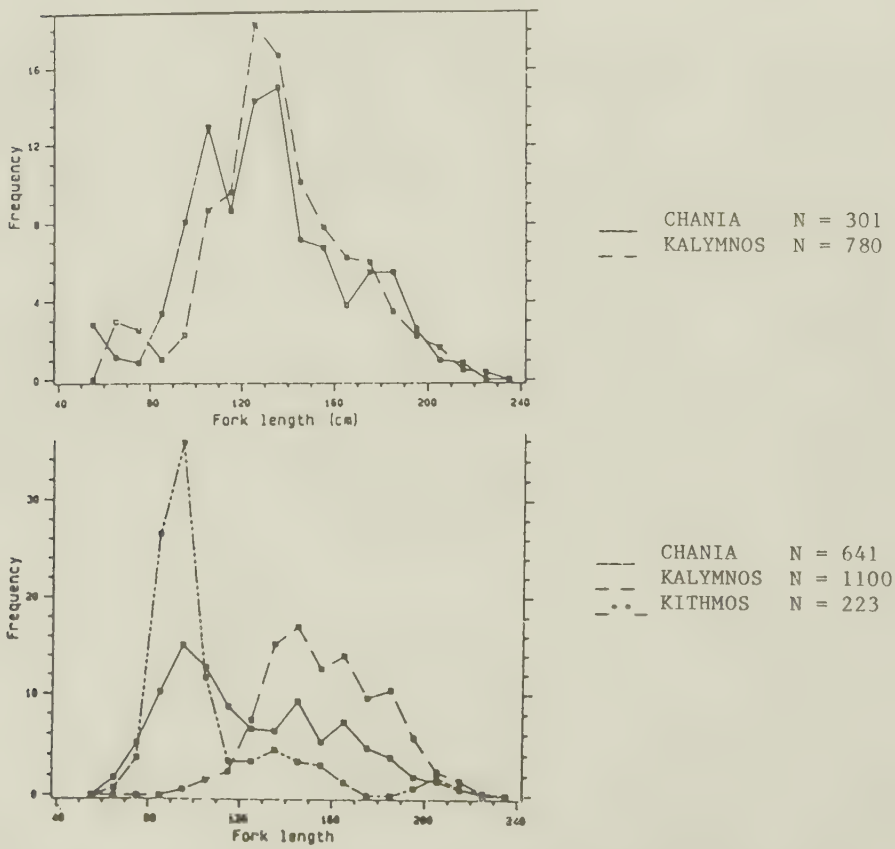

Figure 2 Length frequency distribution of swordifish in samples taken from the catches at the pilot ports during the years 1986 and 1987

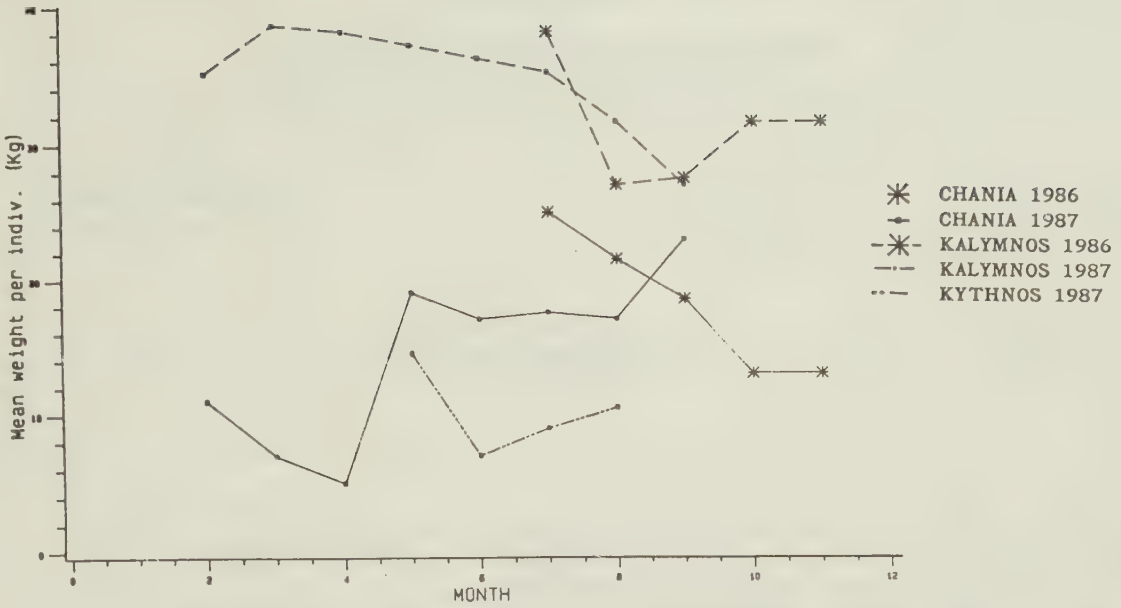

Figure 3 Distribution of mean weight per individual swordfish in samples from catches unloaded at the pilot ports during 1986-87

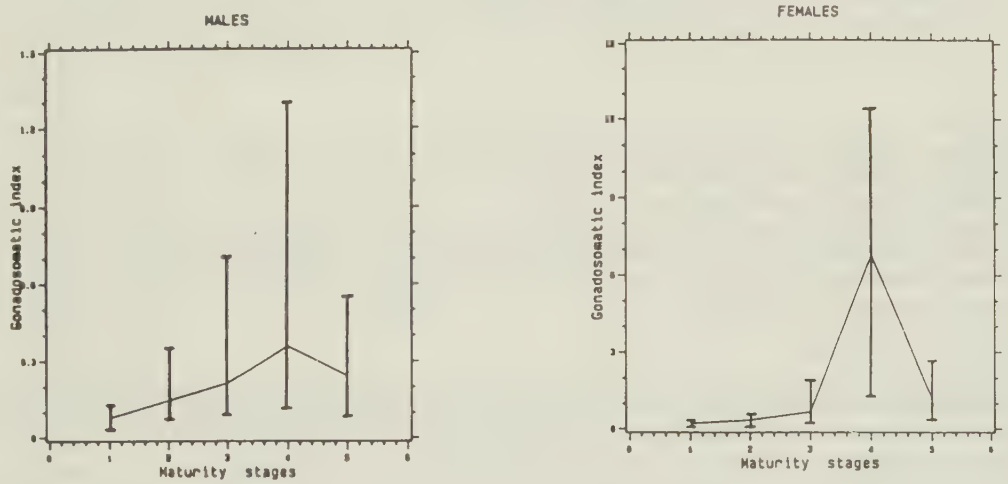

Figure 4 Variation of the average gonadosomatic index values of swordfish during the course of the maturation process. The vertical lines represent the range of the index in each maturity stage

APPENDIX/ANNEXE P

Fisheries for Large Scombrids in Greek Waters: Catches of Thunnus alalunga (Bonn 1788)

by

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ABSTRACT

The results of investigations on albacore fishery in the Greek Seas in 1986 are reported on. Mostly concentrated in the Sporades Islands and in the Chalkidiki peninsula, 169 vessels carried out this activity for a yearly total catch of about 500 tons.

In the pilot port of Alonisos fishing effort and cpue were also calculated, while size distribution and length-weight correlation were studied for a significant sample.

1. INTRODUCTION

Literature did not report information on the distribution of albacore in the seas around Greece or on its fishery by the Greek fishing fleet.

It was therefore necessary within the framework of the programme on the large Scombrid fishery, to direct some attention to this species in which the operators of various Mediterranean countries are becoming increasingly interested.

2. MATERIALS AND METHODS

Data on the number and position of the fishing ports, number and size of the vessels practising the albacore fishery, fishing grounds and total catch were obtained through interviews, on-the-spot investigations and direct study.

For the study of fishing effort and cpue was considered the albacore fishery by Alonisos fleet in the Sporades. As fishing in this harbour was carried out with two different gears (longline and troll-line) we have calculated fishing effort and cpue separately in each case.

For longline fishing effort was obtained with the formula:

$$E = \frac{\bar{a}}{1\,000} \times d$$

where $\frac{\bar{a}}{1\,000}$ represents the number of hooks set daily, divided by the unit of measure of the effort considered as 1 000 hooks.

1/ "This study does not necessarily reflect the opinion of the Commission of European Communities and does not prejudice their future attitude in this field"
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For the troll-line it was obtained with the formula:

$$E = h \times d$$

where h represents the average number of working hours each fishing day and d the fishing days. Cpue were calculated in both biomass and number of specimens with the formula:

$$E = \frac{kg}{E} \text{ and } \frac{\text{No. specimens}}{E}$$

For the study of size distribution, the fork-length of 868 individuals was measured during the two months, September-October, fishing period in 1986.

The total weight of the same individuals uneviscerated was also taken, and the fork length-weight relationship computed by the formula: $W = a \times LF^b$ where W = total weight of fish in kg, LF = fork length in cm and a,b are constants.

3. RESULTS

3.1 Harbours and Vessels

Table 1 reports the regions and the corresponding number of vessels, with relative sizes, that carry out the albacore fishery. The 169 vessels operating are mainly concentrated in the Chalkidiki region and specifically at P. Kufo where all the vessels collect at the beginning of the fishing season and remain for its duration. Another important fishing port for the albacore fishery is Alonisos in the Sporades, with a fleet of 64 vessels. At Alonissos there is a well-organized fishermen's cooperative society which organizes the delivery and the selling of the catch.

3.2 Fishing Period

The fishing period for albacore is shown in Table 1 together with the number of boats involved. It begins around 15 August. September, October and November are the busiest months.

3.3 Fishing Areas

From our information the most important zone for albacore in the Aegean is the area between the Sporades islands and the Chalkidiki peninsula. This fishing ground is exploited by the most important fleets for the albacore fishery. Another much less important area is facing the Gulf of Patra. Other areas (Lesvos, Kalymnos, Leros) are marked on the map where we have ascertained and demonstrated the presence of albacore during the tagging of young swordfish in 1985 and 1986. This fact caused the interest of the local fishermen and they began exploiting the albacore resources but soon they stopped because of the low prices offered by traders.

3.4 Systems of Capture

Fishing equipment used is longline and troll-line. It is not to be excluded that fishermen use both at the same time. The longline for albacore, with which young blue-fin tuna are occasionally captured, is made up of a mainline of monofilament nylon of diameter 120 from which single thread sidelines of diameter 0,80 lead of at 15 m intervals with No. 7 hooks. It is about 15 km long and has about 1 000 hooks.

The floats, 1 litre in capacity, are generally attached every 7 hooks. Setting begins around 3.00 am, and goes on for two hours. Recovery begins after sunrise anda lasts for about three hours. Sardina pilchardus Walb or Sardinella aurita C.V. are used as bait. The troll-line is used with various kinds of artificial bait. Each boat uses two trolling lines.

3.5 Total Catch

Total albacore production was 484 tons (Table 3) of which 336 tons (69,43%) came from the Chalkidiki region. The other zones with reasonable quantities of catch were, in order of importance: the Sporades islands (57.6 tons), Thessaloniki (35 tons), Kavala (31.5 tons) Magnisia (21.6 tons),

The average yearly catch per vessel was 2.86 tons with a maximum value of 7 tons for the vessels of Thessaloniki and a minimum of 0.4 tons for the vessels of Peloponnisos.

3.6 Fishing Effort and cpue

The data (Tables 4, 5, 6 and 7) are referred to the 1986 fishing season. The pilot port considered for albacore fishing was Alonisos in the Sporades. As fishing in this port was carried

out with two different gears (longline and troll-line) we have calculated fishing effort and cpue separately in each case.

3.6.1 Longline fishery

In the months of September and October 1986, 20 vessels took part in the longline fishery. As some of them did not work continuously, all the fishing period, their number for each month was taken as 17. From Tables 4 and 5 it can be seen that these boats totalled 156 fishing days, capturing 2 783 albacore for a total weight of 16 007 kg, with an average weight of 5.75 kg. Fishing effort was 160.9 and cpue in number of individuals had an average value of 17.39 while the average value by weight was 100 kg.

3.6.2 Troll-line fishery

In 1986 45 vessels were involved in this activity at Alonisos port. In the September-October period (Tables 6 and 7) they totalled 471 fishing days with 3 585 working hours, capturing 5 546 individuals for a total weight of 28 835 kg with an individual average weight of 5.20 kg. Cpue in number of fishes reached 1.55 while in biomass it was 8.04 kg. Fishing effort was 3 585.

3.6.3 Size distribution

The length of 868 individuals was measured at Alonisos. Size distribution is indicated in Figure 1. Minimum size found was 55.5 cm and maximum was 81.1 cm. Individuals with LF between 60 and 70 cm corresponding to 2 years of age (Cefali et al., 1986) were more numerous (61.5%) followed by a reasonable quantity with LF between 71 and 80 cm probably 3 years old (36.6%). Size distribution over the months can be seen in Figure 2.

3.6.4 Length-weight correlation

Length-weight relationship was calculated for all 868 non-eviscerated fishes. The equation obtained was:

$$W = 4.183 \times 10^{-5} \times LF^{2.80} \quad r = 0.970$$

3.6.5 Tagging

Eighteen individuals were tagged. They were captured to the east of the island of Kalymnos, 1-2 miles from the coast. No one has been recaptured yet.

4. CONCLUSIONS

Although Ninni (1923) claims that this species is not widespread in the Greek seas, our observations indicate that its distribution area is quite wide even if the only area where fishing is regularly carried out is between the Sporades islands and the peninsula of Chalkidiki. We believe that the two main reasons for this scarce activity are:

1. in many zones, as in the eastern part of the Aegean, this sepcies is not known even if present;

2. market demand is not enough to encourage fishermen to take an interest.

The size distribution indicates that fishing effort is mainly directed to fishes 2 or 3 years old, and that the fishing area represents a trophic area of concentration.

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Table 1

Division of albacore fishing vessels according to the size for each geographical zone

ZONES	NUMBER OF VESSELS	LENGTH OF VESSELS (m)		
		< 9	9 - 14	> 14
PELOPONISOS	3	-	3	-
SPORADES	64	42	20	2
MAGNISIA	9	-	3	6
KAVALA	7	7	-	-
THESSALONIKI	5	-	-	5
CHALKIDIKI	80	17	35	7
EVIA	1	1	-	-
TOTAL	169	67	61	20

Table 2

Distribution of vessels in the fishing period of albacore

ZONES	JAN.-JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
PELOPONISOS	-	-	3	3	3	-
SPORADES	-	2	64	64	39	-
MAGNISIA	-	-	8	8	2	-
KAVALA	-	1	4	6	6	-
THESSALONIKI	-	-	5	5	-	-
CHALKIDIKI	-	30	80	80	80	40
EVIA	-	-	1	1	-	-
TOTAL	-	33	162	164	127	40

Table 3

Total albacore catches per region and average annual catch per vessel in the year 1986

Z O N E S	NUMBER OF VESSELS	TOTAL CATCH (t)	AVERAGE CATCH PER VESSEL (t)
PELOPONNISOS	3	1.2	0.4
SPORADES	64	57.6	0.9
MAGNISIA	9	21.6	2.4
KAVALA	7	31.5	4.5
THESSALONIKI	5	35.0	7.0
CHALKIDIKI	80	336.0	4.2
EVIA	1	1.0	1.0
TOTAL	169	483.9	2.86

Table 4

Fishing effort and cpue referring to longline fishery estimated for Alonisos fishery

	SEPTEMBER	OCTOBER	TOTAL
Number of vessels	17	17	20
Fishing days	80	76	156
No of Hooks	1077	972	1026
Fish. effort (x 1000hook)	86.15	73.90	160.90
$CPUE_{indiv.alalunga}$	20.94	13.25	17.39
$CPUE_{biom.\ alalunga}$	118.36	78.63	100.02
$CPUE_{indiv.bluefin}$	1.06	0.07	0.6
$CPUE_{biom.\ bluefin}$	5.09	0.36	2.91
$CPUE_{indiv.\ total}$	22.25	13.38	18.16
$CPUE_{biom.\ total}$	125.79	80.19	104.74

Table 5

Summarized data for longline captures from Alonisos fishery

	SEPTEMBER	OCTOBER	TOTAL
Individ. of albac.	1804	979	2783
Biomass albac.(Kg)	10196	5811	16007
Aver.weight albac.	5.65	5.93	5.75
Individ. of bluef.	91	5	96
Biomass bluef.(Kg)	439	27	466
Aver.weight bluef.	4.82	5.4	4.8
Total individuals	1917	989	2906
Total biomass	10837	5926	16763

Table 6

Fishing effort and cpue estimated for Alonisos troll-line fishery in 1986

	SEPTEMBER	OCTOBER	TOTAL
Number of vessels	41	38	45
Fishing days	266	205	471
Av. hours/vessel	7.5	7.78	7.6
Trol.line/vessel	2	2	2
Fish. effort(Hours)	1990	1595	3585
$CPUE_{indiv.\ alalunga}$	1.5	1.6	1.55
$CPUE_{biom.\ alalunga}$	7.75	8.4	8.04
$CPUE_{indiv.\ bluefin}$	0.29	0.02	0.17
$CPUE_{biom.\ bluefin}$	1.80	0.07	0.83
$CPUE_{indiv.\ total}$	1.8	1.62	1.72
$CBUE_{biom.\ total}$	9.15	8.52	8.87

Table 7

Summarized data of the catches by the Alonisos troll-line fishery in 1986

	SEPTEMBER	OCTOBER	TOTAL
Individ. of albac.	2996	2550	5546
Biomass albac.(Kg)	15414	13421	28835
Av.weight alb.(Kg)	5.14	5.26	5.2
Individ, of bluefin	579	32	611
Biomass bluef.(Kg)	2785	175	2960
Av.weight bluef.(Kg)	4.8	5.48	4.84
Total individuals	3575	2582	6157
Total biomass	18199	13596	31796

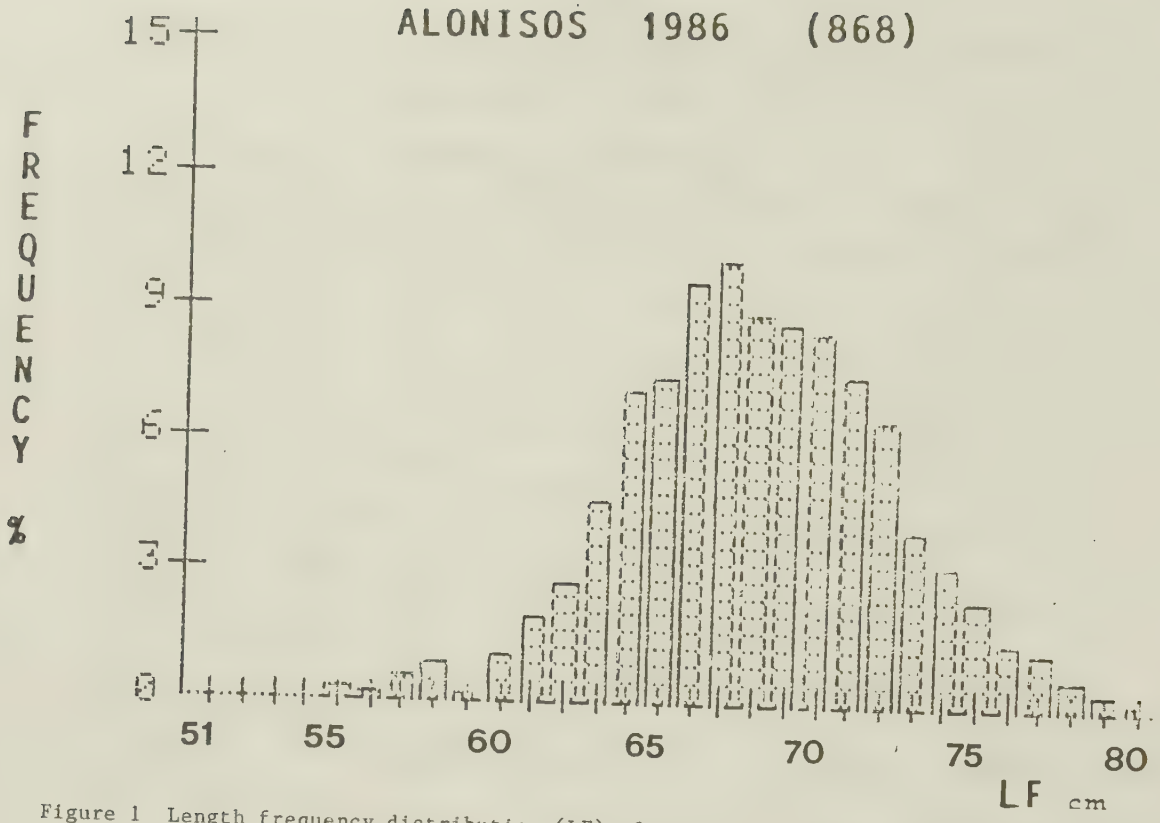

Figure 1 Length frequency distribution (LF) of Thunnus alalunga. Alonisos fishery, 1986

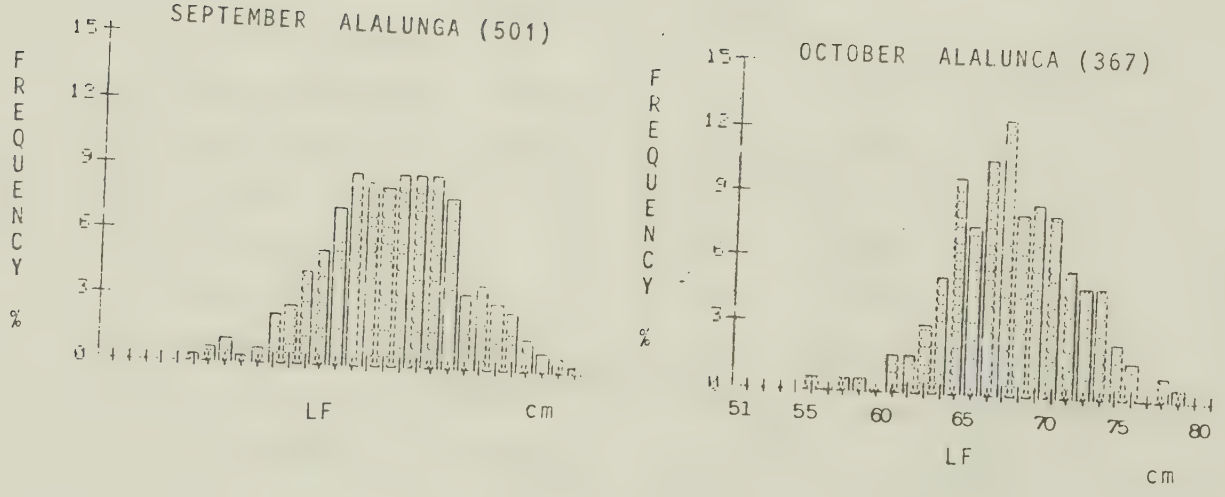

Figure 2 Length frequency distribution (LF) of Thunnus alalunga in the months of September, October. Alonisos fishery, 1986

APPENDIX/ANNEXE Q

Fisheries for Large Scombrids in Greek Waters: Catches of Bluefin Tuna (Thunnus thynnus L.)

by

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This study was realized with financial aid from the Commission of the European Communities[1/]

ABSTRACT

Fishing activity for bluefin tuna in Greece in 1986-87 is described. This fishery is practised specifically only by five fleets with a total number of 50 vessels and the total annual catch in 1986 was 131 t. This include a sporadic catch by other fleets in the course of the albacore fishing campaign. In 1987, production was lower. The cpue, size distribution and length-weight correlations are reported.

1. INTRODUCTION

As may be deduced from the writing by Homer, Aeschylus, Herodotus and Aristotle, fishing for tuna in Greece goes back to ancient times and must have been carried out with coastal nets "tonnara".

In fact as R. Sara (1983) likes to recall, Herodotus, referring to the times of Pisistratus (550 B.C.) wrote "The net is ready and skilfully put to sea, in the moonlight the plump tuna fish will come".

However it must have declined more and more over the centuries, so much that Ninni (1923) quoting from one of his works in 1921 says "Prof. Vinciguerra who was in Greece for a long time studying that fish species says that, in Greek Seas, at least in the Aegean, real tuna are not numerous...." ".... the only places where tuna are caught are Melina in the Gulf of Volo and Gialta in the Eubea". The situation recorded by our research, was not very different untill 1986, but with an awakening of interest on the part of operators due to demand by the Japanese market, in the near future, this will probably promote the consequent expansion of fishing areas, and increase in production. This investigation aims at the acquisition of information on the distribution of the species in Greek Seas and on the present exploitation of the resource.

2. MATERIALS AND METHODS

On the spot investigations and information obtained directly provided the number and sizes of vessels.

Two harbours were monitored for fishing effort and cpue: Kavala where fishing was carried out with pole-line and Alonisos where bluefin are caught occasionally, together with albacore, by long-line and troll-line.

Fishing effort for pole-line and troll-line , was defined from: $E = h \times d$

where h represents the average number of working hours for fishing per day, and d the fishing days.

1/ "This study does not necessarily reflect the opinion of the Commission of the European communities and does not prejudice their future attitude in this field"
"The text of this publication may be reproduced, in whole or in part, quoting the source"

For the long-line it was obtained with the formula

$$E = \frac{\bar{a}}{1\ 000} \times d$$

Where $\frac{\bar{a}}{1\ 000}$ represents the average number of hooks immersed daily, divided by the unit of measurement of the effort in 1 000 hooks; and d the number of days fished. Biometric data was collected in the same harbours.

For the study of size distribution at Kanala the length from the base of the pectoral fin to the fork (Lp) of 381 individuals was taken in 1986, and 156 in 1987. In 27 individuals the fork length (FL) was also measured and the FL-Lp relationship was calculated. The weight of 594 specimens eviscerated and decapitated was taken over the two years period.

At Alonisos the fork length and the total weight of 100 specimens was measured in 1986. The fork length-weight correlation was computed.

3. RESULTS

3.1 Harbours and Vessels

Only 5 zones with a total of 50 vessels whose sizes are shown in Table 1, are involved in bluefin fishery. The zone with the highest number of vessels (33) is Kavala in the north Aegean. Bluefin is considered fish by catch in albacore fishery carried out in the zones of Halkidiki and Sporades Isles.

3.2 Fishing Area

Although personal experience leads us to consider a wide distribution of bluefin tuna in Greek Seas, its fishery is carried out in quite limited zones. The areas in which this fishery is carried out today are the peninsular of Hallidiki, the northern Gulf of Evia and the area in front of the Gulf of Patrass. However from personal observation there is a diffuse presence of bluefin tuna and albacore in various other zones of the Aegean, in particular in the Dodecannisos and near Lesbos. The accidental catch of tuna by vessels during swordfish and albacore fishery also confirms that the diffusion of this species is quite wide but as far as we know, through direct information from fishermen, this resource is not developed due to scarce market demand and lack of suitable fishing techniques.

3.3 Fishing Period

The fishing period for bluefin tuna (Table 2) begins at the end of August and continues to the end of November. The four vessels of Rodopi that fish in spring, and the two vessels of Kalimnos equipped with Japanese long-line that have begun fishing in March, since 1987 are exceptions.

3.4 Systems of Capture

Equipment used for capture are: pole-line, troll-line, long-line surrounding nets and, since 1987, Japanese long-line. The pole-line is made up of a stainless steel hook attached to a steel cord about 1 m long and 2 mm in diameter, attached to a plaited nylon line 8 mm in diameter and about 25 cm in length.

This equipment is used at Kavala for the capture of "giant" tuna attracted by chumming sardines thrown into the sea at regular intervals near the vessel are caught with pole and line that is baited with sardine.

The long-line is an occasional means for capture of little tuna (average weight: 5 kg), principally being used for swordfish and albacore fishing which provides a reasonable catch of young specimens. This equipment is used in the waters of the Sporades, and Halkidiki, where they also use trolling.

Encircling gillnets constitute another means of capture. They are utilized by 4 vessels of Rodopi, in spring to catch in this case, individuals from 10-60 kg these are nets, 1 000 m long and 32 m high made of 3 bands the top band 50 cm high, with meshes of 5 cm where floats are attached, a middle band 31 cm high with 16 cm meshes, a bottom band 50 cm high with 5 cm meshes where ballast is attached. They have no form of closure. Fishing is carried out by two vessels that work in 20-30 m depth, surrounding the sighted shoal and driving the fish into the gillnets by noise. One vessel of Kavala and perhaps some others of Halkidiki and Thessaloniki use purse seines with meshes of 22-35 mm.

3.5 Experimental Fishing with Japanese Long-line

The Japanese long-line was used experimentally for the first time in Greece in 1987. In the fishing season of 1987 some Japanese operators had made contact with local co-opeerative societies in Kavala and Kalimnos for experimental fishing and commercialization of bluefin tuna.

In October to December about 230 giant tuna were caught by a modified long line technique for an average weight of 130 kg. The eviscerated and decapitated fish were sold to the Japanese at Dr. 800 per kg.

3.6 Total Catch

The total production of bluefin tuna for 1986 was 125 t Table 3. The most productive area being Kavala with 43.5 t equal to 34.78% of total catch. Other important zones were Halkidiki with a production of 40 t fished in the course of the albacore campaign, and Rodopi with 28 t.

The average annual catch per vessel was 0.67 t with a maximum value of 7 at Rodopi and a minimum value of 0.3 in Peloponnisos.

In 1987 although the fishery at Kavala was more intensive the production diminished to 25.5 t. About 10 bluefin were taken in October near the coasts of Thrace and about 80 giant fishes at Halkidiki at the end of November.

In October-December 1987, about 230 specimens were captured in the area of Kalymnos at an average weight of 130 kg. Total catch data of 1987 are not yet available.

3.7 Fishing Effort and Cpue

At Kavala 25 vessels worked in 1986 for 210 days totalling 1 551 working hours (Table 4) capturing 382 giant tuna for a total weight of 43 421 kg average individual weight 113.67 kg. Monthly variations in fishing effort and biomass caught are expressed in Figure 1, cpue is seen in Figure 2.

In the same harbour in 1987, 23 vessels fished with pole and line and totalled 333 working days for a total of 2 005 hours. They captured 212 individuals with an average weight of 112.7 kg and a total weight of 23.901 kg (Table 5). Notwithstanding the increase in effort, there was a decrease in values of both total catch and cpue.

Average weight variations over the months in the two-year period are shown in Figure 3.

The results for the harbour of Alinisos where bluefin is considered a by catch to the albacore fishery are reported in Table 6.

3.8 Size Distribution

3.8.1 Alonisos

One hundred specimens were measured. FL was between 60 and 103.6 cm. In the histograms of Figure 4 it is possible to see that the most frequent sizes were between 62 and 65 cm (71%) relative to two-year old individuals.

3.8.2 Length-weight correlation

The length-weight correlation on the 100 individuals (not eviscerated) was calculated, as follows:

$$W = 9.213 \times 10^{-5} \times FL^{2.61} \qquad r = 0.930$$

Where W is expressed in kg. and FL in cm

3.8.3 Kavala (pole-line)

In the port of Kavala 281 speciments of blue-fin tuna were measured.

As already said, the fish arrived in the harbour already decapitated, so the length of most of the specimens was calculated from the base of the pectoral fin to the fork.

As it was possible to measure the length from the superior jaw to the fork (min. 187 - max. 234) and from the base of the pectoral fin to the fork (min. 134 - max. 175) we calculated the correlation between the two lengths obataining the formula:

$$FL = 13.216 + 1.289 \times Lp \qquad r = 0.992$$

Where Lp represents the length from the base of the pectoral fin to the fork.

In Figure 5, the distribution of the frequencies of fork length is reported. Animals had a minimum size of 162 cm, and a maximum size of 253 cm, so they were between 7 and 14 years old according to Arena and Cefali (1980). The length classes mostly represented were those between 185 cm and 235 (86.5%) corresponding to animals between 9 and 12 years old. In 1987 the FL of 156 specimens was measured with the same method. Frequency distribution is shown in Figure 6. The sizes were between 170 and 272 cm, and the lengths most frequently registered were between 185 cm and 235 cm. The catch this year also fell within the same age range with a prevalence of 9-10 year old individuals.

4. DISCUSSION

Although it is indicated that in the Greek Seas there are bluefin of various ages - even juveniles of 1 kg were captured during swordfish autumn tagging - fishing areas are very confined and limited to the north Aegean and to the east of Kalimnos island. A specific fishery is mainly carried out on giant autumn tuna, and through professional fishermen, presents all the features of a sport fishery. It is practised from September to November near the coast where as there is no information about bluefin abundance in the open Aegean sea except from the occasional capture of young bluefin (w:5 kg) to the north of Sporades islands.

Ripening bluefin exploited in other parts of the Mediterranean, are fished only by four vessels in Greek waters of Rodopi, in April-May.

All the above, make us suppose either that their presence is quite widespread in the Greek waters but up to now has not attracted local fishermen or that it is really limited.

The positive reotropism that bluefin presents has to be taken into consideration in the study of its migration. At least in the west and central Mediterranean, bluefin follows the surface Atlantic water current. Ninni (1923) refers that according to Greek and Turkish fishermen, bluefin migrates keeping the right eye along the coast.

Looking at the current circulation in the Aegean Sea (Georgopoulos, 1984) we notice that the beginning of giant tuna fishery coincides to the east of Kalimnos the entrance of warm surface waters from the East Mediterranean into the Aegean, passing along the turkish coast and Dodecanisos islands, and extending temporarily into the area to the south of the islands of Andros-Tinos-Miconos-Ikaria-Samos.

In the north Aegean, presence of bluefin in autumn seems to follow the water current of the Dardanelles. A continued collaboration with other Mediterranean countries will be needed in order to improve our knowledge of the bluefin resource.

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THUNNUS THYNNUS FISHING AREAS AND FISHING PORTS IN THE GREEK SEAS

Table 1

Division of bluefin fishing vessels according to the size for each geografical zone

ZONES	NUMBER OF VESSELS	LENGTH OF VESSELS (m)		
		< 9	9 - 14	> 14
PELOPONISOS	4	-	4	-
SPORADES[a]	65	42	21	2
KAVALA	33	19	11	3
RODOPI	4	-	4	-
THESSALONIKI	5	-	-	5
HALKIDIKI[a]	80	17	35	7
EVIA	4	3	1	-
TOTAL	195	81	76	17

a/ In these zones bluefin is considered a by-catch

Table 2

Distribution of vessels in the fishing period of Thunnus thynnus

ZONES	Vessels	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PELOPONISOS	4	-	-	-	-	-	-	-	-	4	-	-	-
KAVALA	33	-	-	-	-	-	-	-	-	33	33	33	-
RODOPI	4	-	-	-	1	4	3	-	-	-	-	-	-
THESSALONIKI	5	5	-	-	5	5	-	-	-	5	5	5	5
EVIA	4	-	-	-	-	-	-	-	4	4	-	-	-
TOTAL	50	5	-	-	6	9	3	-	4	46	38	38	5

Table 3

Total bluefin tuna catches per region and average annual catch per vessel in the year 1986

ZONES	No vessel	Total catch (tn)	Average catch per vessel (tn)
PELOPONISOS	4	1.2	0.3
KAVALA	25	43.5	1.7
RODOPI	4	28.0	7.0
SPORADES	64	6.4	0.1
THESSALONIKI	5	3.5	0.7
KALKIDIKI	80	40.0	0.5
EVIA	4	2.4	0.6
T O T A L	186	125.0	0.67

Table 4

Summarized data of catches, fishing effort and cpue estimated for Kavala bluefin fishery during the period August-November 1986

	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	TOTAL
No of vessels	8	19	5	9	25
No fish. days	16	118	7	69	210
No hours/vess.	9.3	8.0	2.6	6.3	7.4
No bluefin	44	201	11	126	382
Kg bluefin	4817	25418	1388	11798	43431
Average weight	109.5	126.5	126.2	93.6	113.7
E (X hour)	149	949	18	415	1551
CPUE in number	0.2	0.2	0.6	0.3	0.2
CPUE in biom.	32.3	26.8	77.1	27.1	28

Table 5

Summarized data of catches, fishing effort and cpue estimated for Kavala pole-and-line bluefin fishery during the period August-November 1987

	AUGUST	SEPTEMBER	OCTOMBER	NOVEMBER	TOTAL
No of vessels	3	9	20	13	23
No fish.days	3	77	174	79	333
No hours/vess.	2	6.3	6.4	5.1	6.0
No bluefin	0	29	144	39	212
Kg bluefin	0	3684	16472	3745	23901
Average weight	-	127	114.4	96	112.7
E (X hour)	6	485	1113	401	2005
CPUE in number	0	0.06	0.13	0.10	0.11
CPUE in biom.	0	7.6	14.8	9.3	11.9

Table 6

Summarized data of catches, fishing effort and cpue estimated for Alonisos long-line and trolling line fishery in 1986

	LONG - LINE	TROLLING-LINE
No of vessels	20	45
Fishing days	156	471
No bluefin individ.	96	611
Kg bluefin	466	2960
Average weight (Kg)	5.7	4.5
No total individual	2906	6157
Kg total catch	16763	31796
Fishing effort	160.9[a/]	3585[b/]
$CPUE_N$ bluefin	0.6	0.2
$CPUE_B$ bluefin	2.9	0.8

a/ E (x 1 000 hooks)
b/ E (x hour)

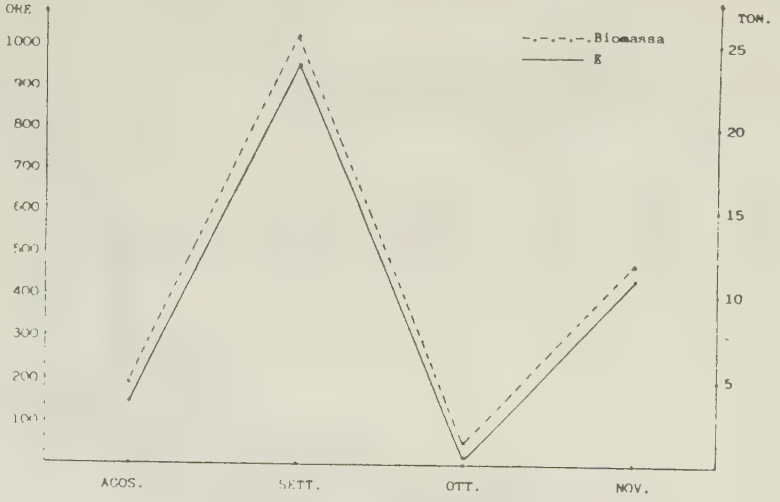

Figure 1a - Monthly variations of fishing effort and bluefin catches (biomass) for the fishery of Kavala during 1986

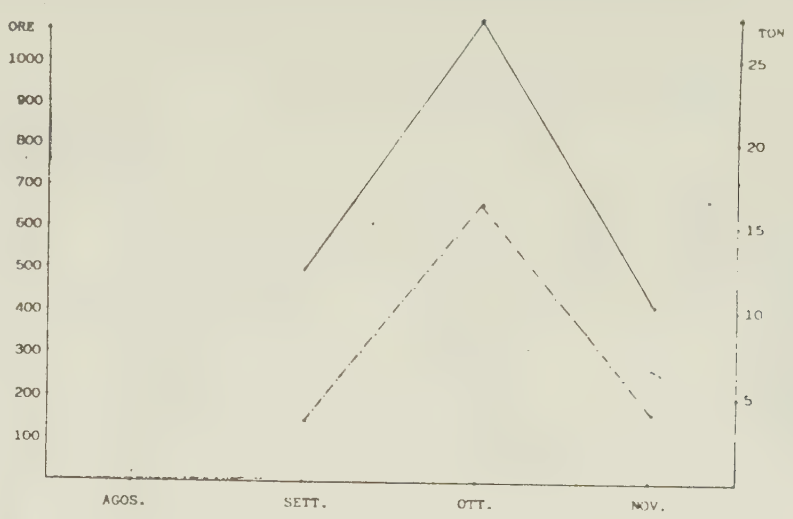

Figure 1b - Monthly variations of fishing effort and bluefin catches (biomass) for the fishery of kavala during 1987

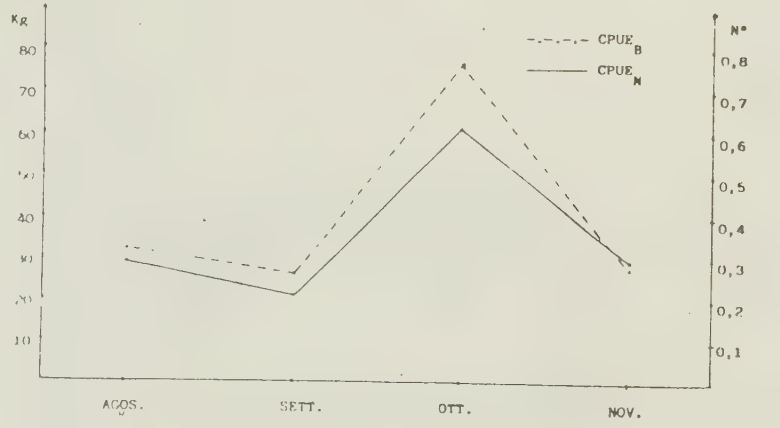

Figure 2a - Monthly variations of cpue in number of fish and in biomass (catches) for bluefin fishery in Kavala during 1986

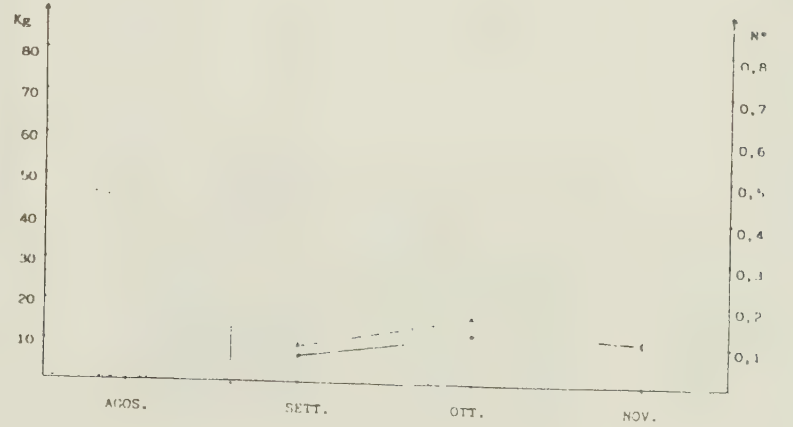

Figure 2b - Monthly variations of cpue in number of fish and in biomass (catches) for bluefin fishery in Kavala during 1987

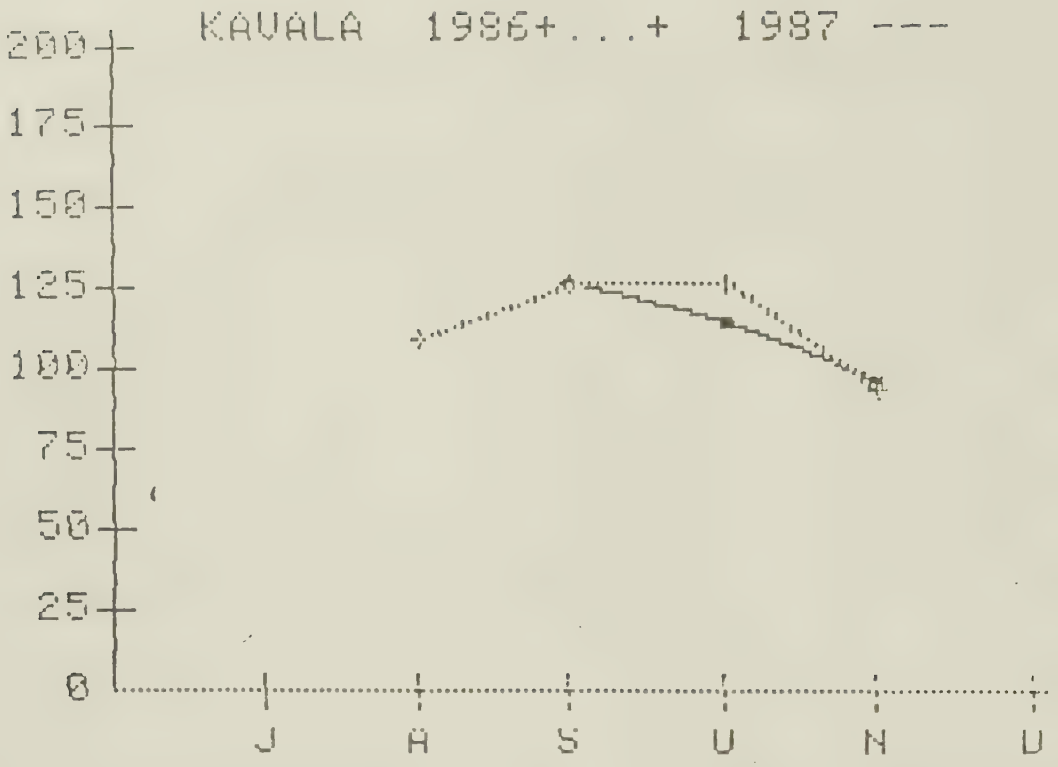

Figure 3 - Monthly variations of Thunnus thynnus average weight. Kavala fishery 1986/87

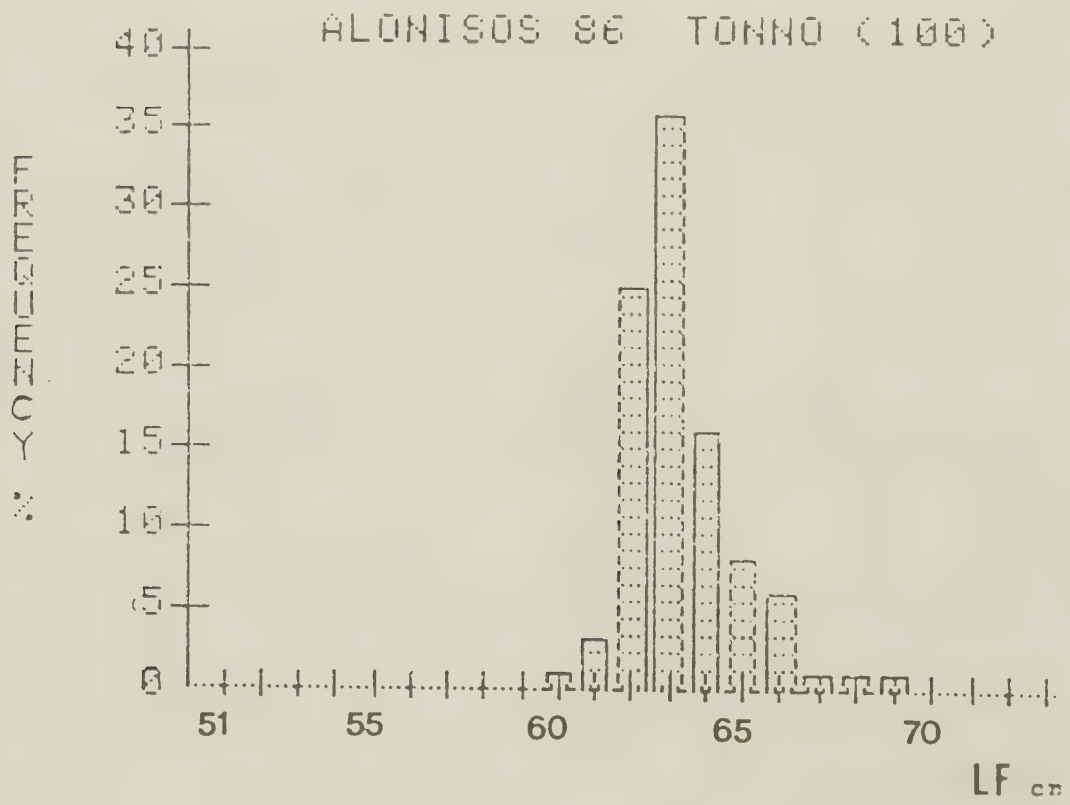

Figure 4 - Length frequency distribution (LF) of Thunnus thynnus. Alonisos fishery 1986

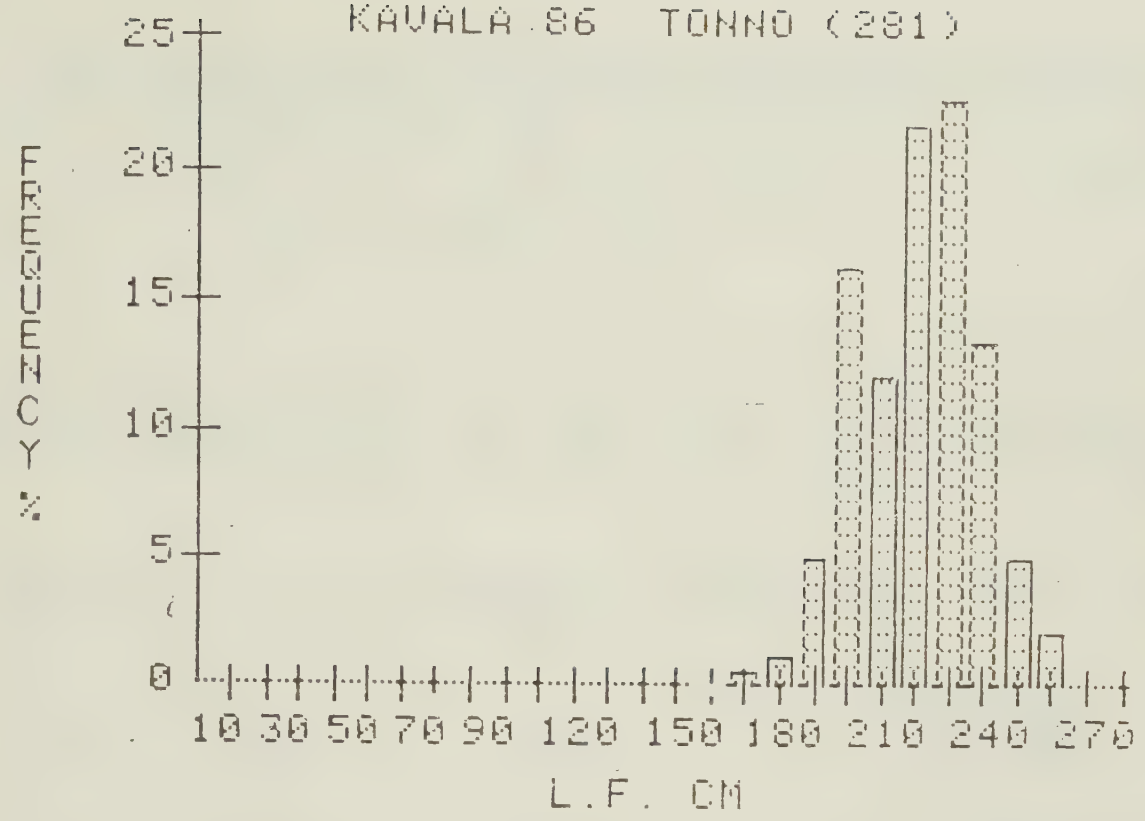

Figure 5 - Length frequency distribution (LF) of Thunnus thynnus. Kavala fishery 1986

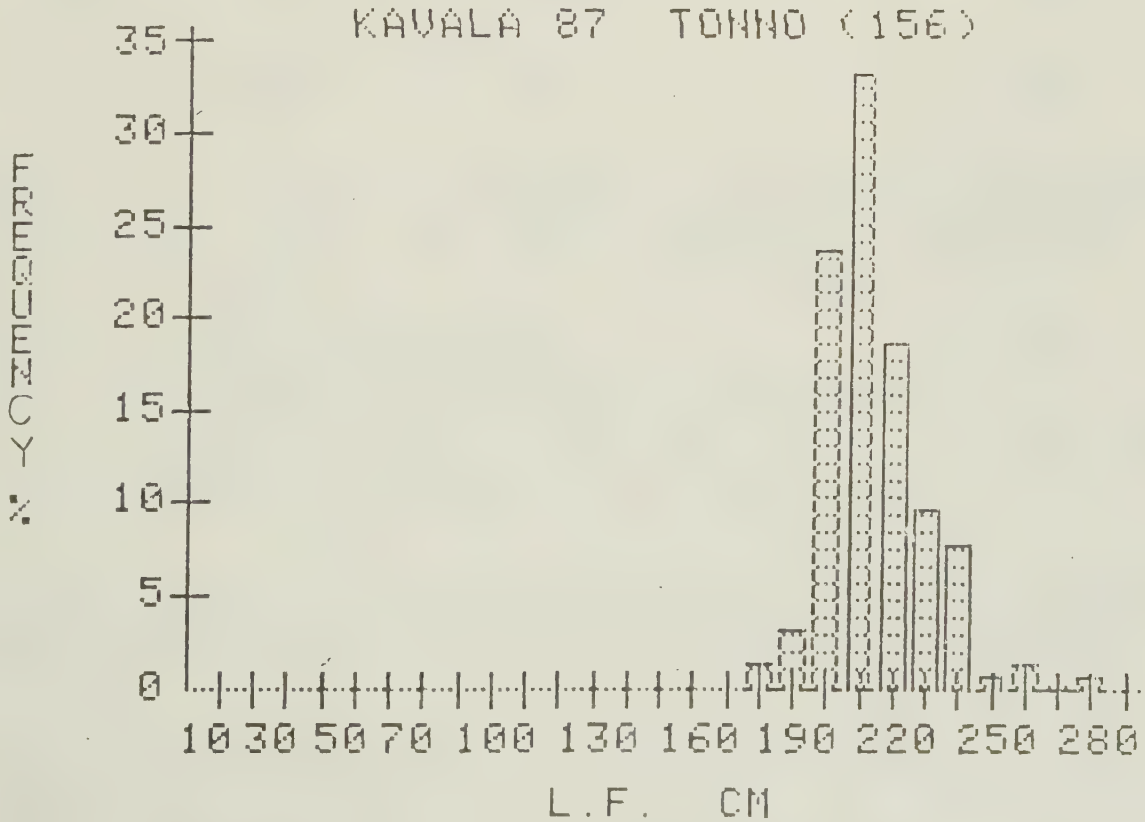

Figure 6 - Length frequency distribution (LF) of Thunnus thynnus Kavala fishery 1987

APPENDIX/ANNEXE R

Report on the Egyptian Fisheries Focusing on the Mediterranean

by

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1. INTRODUCTION

Egypt has a population of about 50 million with an average growth rate of 2.36%. The current yearly fish production is about 280 000 t. Egyptian Government policy is to increase the production through different activities to attain self sufficiency at 700 000 t in year 2000 since the country has great potential for fish production.

The present fish production is as follows:

Sources	Area (fedds)[1/]	Production (tons)	%
MARINE FISHERIES			
Mediterranean	684 000	25 000	11.00
Gulf of Suez and Red Sea	4 607 680	20 000	8.81
NORTHERN LAKES			
Bardawil	160 000	1 500	0.66
Portfouad and Nozha Hydrome	25 000	600	0.26
Burullus	136 600	20 000	8.81
Manzala	280 000	70 000	30.84
Edku	16 000	8 000	3.53
Maryut	15 000	9 000	3.96
CLOSED LAKES			
Quaroun	55 000	1 650	0.72
Wady El Rayan	42 000	1 100	0.48
SOUTHERN LAKES			
Nasser	1 000 000	25 500	11.23
INNER WATER			
The River Nile	178 000	25 000	11.00
Fishermen' own consumption		19 650	8.7
AQUACULTURE			
Fish farms	104 000	33 000	
Fish culture in rice fields	411 000	20 000	
TOTAL		280 000	

1/ 1 fedd = 4 200 m²

2. ROLE OF THE GOVERNMENT

The Egyptian Government established the General Authority for Fish Resources Development GAFRD in 1983 by presidential decree No. 190.

The responsibilities of the "GAFRD" are:

- to set up "national" fish sector plan and policy, and implement it;

- to execute the acts No. 123/1983 which mainly deal with fisheries cooperative societies, and No. 124/1983 dealing with fishing, oceanography, living aquatic resources and fish farms;

- to power sailing and rowing boats with motors of 10-25 hp;

- to encourage fishermen to use vessels with 200-300 hp in order to increase production and operate in new fishing grounds;

- to encourage vessel owners to use echosounder and sonar;

- to encourage fishermen to use mechanized systems on board the vessels to reduce the crew;

- to offer cooperative societies different types of loans without interest;

- to conserve fisheries resources;

- to establish governement fish farms, fish hatcheries and fry collection centres.

3. OBJECTIVES FOR FISHERIES DEVELOPMENT

Targets for fisheries development are laid down in Egypt's second five-year plan for socio-economic development (1987-92). These can be summarized as follows:

- distribute the nation's present and future resources in a fair manner;

- increase the degree of self-sufficiency in fish production;

- achieve surplus production "high quality" fish for export;

- increase work opportunities in the fisheries sector;

- a production objective of 350 000 t of fish by 1992 is set: this corresponds to an annual *per caput* consumption of about 6.3 kg. This objective is expected to be realized by:

  - intensification of fish farming in existing farms;
  - concentration on production development from inland natural resources;
  - strengthening of fishermen cooperation societies;
  - strengthening of extension activites;
  - marine fisheries management and development.

4. THE MEDITERRANEAN FISHERIES

The Egyptian Mediterranean Sea coast is about 1 100 km in length, extending from Egyptian Rafah in the east to Salloum in the west. The continental shelf to 200 m depth along the coast is composed largely of silt mud and muddy sand. It widens to a maximum of 25 km in front of the Delta. The fishing grounds along the coast can be divided into three distinct zones:

(i) Eastern zone, Rafah to Port Said 200 km
(ii) Central zone, Port Said to Alexandria 300 km
(iii) Western zone, Alexandria to Salloum 600 km

Most of the fishing operations are concentrated in the central zone.

The main fishing gear and methods are, demersal trawling, purse seine, drifting net, beach seine, longline and trammel nets.

5. LANDING HARBOURS

The following is a list of the main harbours and fish landing places for the Mediterranean. These harbours come under the umbrella of the Authority of Ports and Shipping: Ministry of Transport:

- El Arish
- Port Said
- Espit El Bourg
- Baltim
- Rashid
- Ma'adea
- Abou Quir
- Alexandria
- Marsa Matrouh

All harbours have facilities for supplying vessels and unloading catches.

The production from the Mediterranean is about 11% of the natural catch. It is made by 16 cooperatives with 15 728 members and LE 153 974 capital. There are about 1 552 vessels between 10 and 400 hp, and 866 sailing boats (Table 1).

Table 1

Mediterranean fishing vessels of Egypt

hp	Purseseine	Trawler	Hooks and others
10-50	17	30	699
50-100	19	245	17
100-150	11	332	-
150-200	3	120	-
200-250	1	54	-
400-450	-	4	-
TOTAL	51	785	716

Research Institutions

Many institutions are involving in marine research in Egypt, also research is carried out through cooperative programmes between the Egyptian government and other countries; some institutes are:

- Institute of Oceanography and Fisheries under the umbrella of the Academy of Science Research and Technology;
- Faculty of Science, Alexandria University;
- National Planning Institute;
- Soviet-Egyptian Cooperation Programme "Ichthyology" (1970-71);
- Italian-Egyptian Cooperation Programme "Sopal" (1983).

An extract follows of the results of the last research programme carried out by Sopal.

The Objectives

- Exploitation of fishery resource;
- Resources survey at depths of resources from 150 to 500-600 m;
- Experiment with new fishing technologies such as:

  - deep sea trawling;
  - mid-water two boat trawling;
  - the use of longlines;
  - evaluation of existing stocks and the dynamics of fish populations;
  - survey the present distribution of pelagic species, emphasizing the sardine.

The data was analysed by the Laboratory of Marine Biology and Fisheries at Fano.

Seven different trawlers equipped with an echosounder and sonar carried out two expeditions: one in the spring, and the other in the summer of 1983.

This division was designed to take into consideration seasonal fluctuations of stocks and the presence of migratory species, such as tuna.

It was decided to carry out the research into tuna fish during the second expedition only, as this species enters the Mediterranean in late spring/early summer.

Hydrological Parameters

The measurements and samples were carried out at 25 stations.

Temperature

Using a Bechmann thermoprobe sea temperature was measured at 10 m intervals down to 100 m. The surface temperature in the area varied from a minimum of 25.9°C to a maximum of 28.9°C with highest values close to the coast, decreasing out to sea, and also decreasing from east to west. A sharp lowering took place from 40-60 m (by 6°-8°C). Below the thermocline, the temperature dropped but very gradually down to the minimum of 16°-18°C at 100 m.

Salinity and Nutrient Salts

The surface distribution of salinity in August-September 1983 varied from 3.9% to 39.5%.

The concentration of phosphate distribution varies from 0.2 to 0.3 µg/litre. This figure decreases from the coast toward the open sea.

The figures for ammonia are extremely variable, reaching a maximum of 5.76 and a minimum of 0.01 µg of N/L. In the whole area nitrites are quite low; the range relating to the surface values, being 0.01-0.06 µg N/L. The maximum was observed near the coast. The surface distribution of nitrates was quite homogeneous, with a range from 0.52-1.58 µg N/L.

The comparison of the figures relating to the concentrations of nutrient established in the summer cruise of the vessel "ICHTHYOLOGY" of 1970 and 1971, with what obtained in August-September 1983, lead to the conclusion that the quantity of biogenic elements in the zone has increased, even if these waters are still oligotrophic.

Probably, the influence of the remixing and coastal discharges have become important in the provision of the chimical nutrient base. From the analysis of oceanographic data obtained in the August-September 1983 cruise, we can conclude that this zone is characterized by different bodies of water namely, a surface one, very saline; and a deeper one less saline, with water of Atlantic origin.

Peculiarities of the horizontal distribution of the various parameters were not found, however a gradient, diminishing from the coast seawards was observed, as was a greater concentration of nutrients toward the east, since the coastal current moving south-east conveys the slight summertime coastal discharges in this direction.

6. PELAGIC RESOURCES

The evaluation of pelagic resources by both expeditions was carried out by two commercial motor trawlers equipped with a Simrad echosounder. The net used for the expeditions was a mid-water trawl of "volante" type.

The area over which the evaluation of pelagic resources was carried out extends from Sidi Barrani in the west to El Arish in the east for a strip that goes from 0-500 m in depth. This area was subsequently reduced for depths exceeding 100 m since no shoals of fish were ever located there by the echosounder.

The research work, therefore, took place in an area of about 19 000 km², between the coast and 100 m isobath. In both expeditions a zig-zag course was taken over this zone.

In the zone characterized by the presence of shoals of fish, several hauls were carried out that enabled information to be collected both upon the specific composition of the shoals and density of fish within the actual shoals. For some species of interest, laboratory analyses were carried out upon the various samples collected in order to determine the main parameters of the biology of the particular species. Growth was studied reading the otoliths and scales and an examination of the state of development of the gonads was carried out.

The clupeiformes were predominant within the catches made during the two expeditions; they accounted for 89% of the catch of the first cruise (March-April) and 98% of the second cruise (August-September).

The Main Species

Sardina pilchardus

A cosmopolitan species of great economic importance. It was represented by very small specimens (length under 12-13 cm). The distribution of Sardina pilchardus was different in the two seasons surveyed. In April the species was absent in the area east of Port Said and was presented in the zone between Alexandria and Port Said, while in the second expedition (August-September) the

species was present between Alexandria and El Arish. The distribution according to size shows in some samples the presence of two distinct groups in March-April, and a single group in August-September.

At stations located in depths of less than 130 m the 6-10 cm groups are dominant, at a depth of 130-180 m the 11-15 cm sizes groups predominate, while above 180 m the 14-18 cm sizes are most common.

This observation thus enables us to suggest that the species moves in relation to a biological cycle, with the younger fish near the coast, but as they grow, move away and disperse toward the bottom.

The growth of Sardina pilchardus was studied by means of the analyses of otoliths taken from specimens caught by both the volante nets, and the bottom trawl.

The mean sizes for the various age groups during the two expeditions were:

Group	0	I	II
April	(7)	11.14	- cm
August	(8.4)	12.9	16.04 cm

The data referring to group 0 is in brackets because it is influenced by the selectivity of the net which only allows for fish longer than those of group 0 to be caught.

The L/W ratio was calculated for specimens between 7 and 18 cm long. The equation was:

$w = 0.004668.L^{3.194819}$

where W in g; L in cm.

From the analysis of the gonads from both expeditions it was seen that both females and males showed gonads in a rest period. This confirms what is known for other areas, namely that the reproduction of sardine takes place basically in winter.

The male/female ratio of 0.36 for the first expedition and 0.28 for the second one, showed a prevalence of females over males. In order to interpret such data correctly it is necessary to bear in mind that as most of the specimens dealt with were immature, the male gonads are difficult to recognize and could have often been considered as gonads of indetermined sex.

Sardinella aurita

This is a temperate-warm seas species. In Egypt together with Sardinella maderensis, it is the most important clupeiform in the catches. The species is present between Alexandria and El Arish in March-April, while it is rare in August-September. It accounts 28% of the catch in March-April and 8% in August-September. The graph referring to March-April shows a unimodal distribution. The graph of August-September shows a distinctly bimodal distribution with a first peak at 7 cm, and a second at 14-15 cm. Through the study of otoliths, the average lengths of the various groups were calculated as follows:

Age groups	0	I	II
April	-	12.4	15.05 cm
August	(9.2)	14.4	- cm

The L/W relationship was: $W = 0.00736.L^{3.0244}$

The gonads of specimens caught in March-April were all in a rest period. In August-September the gonads were mature although in the more easterly zone there was still a percentage of immature gonads, thus suggesting a shifted or different spawning period.

The M/F ratio gave values of 0.7 for the first expedition and 0.9 for the second, showing a slight female predominance over males.

Engraulis encrasicolus

This species was foundd in the whole area between Alexandria and El Arish during both expeditions and accounted for 31% and 11% respectively of the total catch.

In the first expedition a modal size of 10 cm prevailed at a depth of less than 160 m, and 13 cm at a depth of more than 160 m; a similar situation was seen for August-September.

The average lengths calculated through the study of otoliths were the following:

Age groups	0	I	II	
April	(8.7)	10.5	12.9	cm
August	(7.1)	12.1	14.8	cm

The L/W relationship during the two expeditions was:

$W = 0.0445198.L^{3.126831941}$

The M/F ratio was 0.6 for the first expedition and 0.99 for the second.

Stock Evaluation

The echosurvey and fishing surveys provided a panorama of the distribution and abundance of pelagic fish. The total area explored was divided into 4 geographical sub-areas:

- sub-area A: Alexandria-Rosetta
- sub-area B: Rosetta-Port Saiid
- sub-area C: Port Said-El Arish
- sub-area D: Alexandria-Sidi Barani

In each sub-area, zones of differing densities of pelagic fish were located using the echosounder recordings. The biomass of pelagic fish was estimated by multiplying the average density of fish in each area by the size of each individual zone.

The figures obtained for the total biomass were:

43 000 t in April
40 000 t in August-September

These estimates include sub-areas A, B and C as no pelagic fish were found in D.

The pelagic resources in the zone are composed of at least five species, for none of these can the whole distribution area be considered to have been explored, nor can the whole of the stocks be considered to have been finally determined, since each species migrates. Some of these movements have been partly identified; for example, the movement from the coast to sea, and from the surface to deeper waters in the case of the sardine and anchovy.

Another important factor is the composition of the various species according to age with abundance of young specimens being greatest in the zone within a depth of 100 m. This zone is principally nursery area, which will then provide older fish over much larger areas.

In order to demonstrate this, we can consider the sardine stocks, which, in March-April, were present in the area in modest quantities, of about 2 000 tons, in the form of one year olds and part of the juveniles born in the course of the previous winter. In the August-September expeditions, almost the whole of the biomass of about 25 000 tons was in this zone. It could be assumed that in the course of the following winter, the majority of these sardines would spread out over a wider, deeper zone, leaving only a small fraction of the year - old sardines in the coastal area by spring.

A similar movement, although spread over the seasons would appear to take place with anchovies: in March-April, anchovies born the previous summer were found in the 100 m zone; once adults, these anchovies would be outside the area, as the hauls with the trawlnet demonstrated in the following

month of August. In this way, the sharp decrease in biomass could be explained between April and August, from 13 000 to 5 000 t.

An important consideration emerging from the tests carried out regards the vulnerability of the pelagic resources to various types of fishing equipment. The shoals of fish are small in size, and in 3 areas they are numerous enough to make fishing with mid-water trawlnets practical. In the other zones there are small scattered shoals and the probability of catching these with mid-water nets of the "volante" type is very low, and certainly not economically viable.

The situation of the pelagic resources would have to be kept under constant surveillance, because due to recent ecological modifications, a stable situation may not have been reached yet; the present situation still being subject to continual variation.

The fact, for example, of having caught anchovies and sardines on the bottom, at a depth of more than 150 m, which is not usually seen in other zones of the Mediterranean, is unusual. A deeper knowledge of feeding habits of these species near the bottom could provide an explanation of this very unusual behaviour.

On the whole, regarding the small pelagic fish resources, it seems that the possibility of rapid increases in production may be excluded, even though the biological potential is higher than the present fishery production level, which in order to develop further, is in need of modest technological innovations.

Demersal Resources

Five trawlers carried out the survey in the zone immediately outside the coastal one which extends from 150 to 800 m in depth, and corresponds to a surface area of about 8 000 km^2.

All vessels are equipped with an echosounder and "Loran". The latter provides a continuous indication of the ships coordinates, the echousounder displays the morphology of the sea-bottom giving information on the types of sediment.

Sepia officinalis

A commercially important species, it lives mainly in shallow waters, moving close to the coast during the spawning season. The largest catches took place at shallowest stations in both expeditions with variable hourly yield. In April the mode of sizes was 10 cm (adult, mature), in summer the mode dropped to 6 cm as the majority of catch is made up of juveniles born in spring. The females are mature from a length of 9 cm; the males from 8 cm. The M/F ratio is 0.56 in April and 0.54 in August; thus there is a constant female predominance.

Mullus surmuletus

This fish leads a pelagic life in the juvenile stages up to about 4-5 cm; changing subsequently to a benthic life. Examination of its distribution shows that Mullus surmuletus is more abundant in the area opposite Alexandria and the Rosetta mouth, with yields tending to diminish toward the east. The best results were obtained at a depth ranging from 150 to 450 m, even though was also caught at a depth of 500 m. On the other hand, the abundance during the second expedition revealed rather poor yields.

In August, however, small quantities of Mullus surmuletus were found from 130 to 300 m. The reduced number of M. surmuletus in the summer catches reflecting an average value of 1.7 kg/h in April, against an average value of 0.3 kg/h in August-September, could be the result of this species moving toward shallower waters for trophic reasons.

Size Distribution

As regards the size distribution of M. surmuletus, there were no large differences between the two expeditions. In fact in spring, of 2 620 specimens a minimum size of 12 cm was caught, and the majority of specimens fell within the 13-17 cm length category; there were no notable variations on this situation in summer.

The scarcity of specimens under 11 cm in size in the catches carried out at a depth of over 130 m, can be attributed to this fishes habits; namely, a preference for shallow waters in the early part of its life. The histograms of distribution in size, relating to the various stations are mostly polymodal, which indicates that the groups of specimens caught are heterogeneous as regards age.

Reproductive Biology

From the total number of specimens caught, samples were taken for biological analysis which show that April is the reproductive period, in that out of 402 females examined, 96% had mature ovaries and 19% ovaries were near maturity; in August the females had ovaries at "rest". The minimum size at sexual maturity is 13 cm for females and 12 cm for males, which correspond to about one year of age.

The M/F ratio on a total of 720 specimens, was 0.79.

Feeding Habits

Stomach content analysis demonstrates that M. surmuletus feeds mainly based on crustaceans, bivalves and other benthic organisms. Among the crustaceans, penaeids were found while among bivalves it was Leda commutata. Small fish were also found.

7. GROWTH

Growth was studied by examination of the otoliths since as scales proved to be difficult to interpret. The following values were obtained (April specimens):

Females

Age Groups	I	II	III	IV
Average	14.8	18.3	20.9	23.5 cm
Limits	13-16	14.21	18-32	21-25 cm

Males

Age Groups	I	II	III	IV
Average	13.5	15.4	17.6	19 cm
Limits	12-14	13-17	15-20	17-20 cm

Different growth rate were found between the two sexes. From these values, the following L_{oo} and K values were obtained for the two sexes by mean of the Ford-Walford method:

Males: L = 29.8 cm
K = 0.14

Females: L = 36.9 cm
K = 0.17

The L/W correlation for the two sexes was then calculated.

The length range considered for females was 13.3-28 cm:

$$W = 0.01215.L^{2.98212}$$

For males the length range was 12.8-24.1 cm:

$$W = 0.00912.L^{3.04702}$$

Mortality

The instantaneous total mortality coefficient was evaluated without separating sexes through the formula:

$$Z = \frac{n.k}{(n+a)\ \ln \frac{L_{oo} - L_c}{L_{oo} - L}}$$

Where: $n_{_}$ = number of specimens measured
$L_{_}$ = average length at catches
L_c = average length at first catch (about 8 cm)
L_{oo} and K obtained from growth study

A Z value of 0.4 obtained. In the whole investigated area (150-600 m) suggest that only natural mortality affects this part of the population. These mortality values cannot be extended to the whole stock however.

8. BIOMASS EVALUATION

Biomass was evaluated using Alverson and Pereira's (1969) method and using a catchability coefficient of 0.7 for the striped mullet. In April a value of 350 t was obtained, and 62 t in August.

9. RECOMMENDATIONS

(a) We need an accurate statistical system (catch and economic statistics).
(b) There is a need for an extension agency to deal with fishermen.
(c) Planning for the fisheries sector must be approached as a complete activity.
(d) More emphasis is needed on marine fisheries management, regulations, and legislation.
(e) Training courses for the fishermen on using new methods, fishing gear and fish handling are needed.
(f) A standardization of statistical system for the southern part of the Mediterranean should be defined.

APPENDIX/ANNEXE S

The Present Situation and Current Trends in Development of Fishing Activities in Greece

by

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1. INTRODUCTION

The fisheries of Greece, as a sector of primary production, is not characterized by impressive numbers. Indeed fishery accounts for only 2% of the Gross Agricultural Product and 0.31% of the Gross National Product, based on 1984 data. However, fishery products are very important for the diet of the Greek population if only because they contain proteins of great value for balanced nutrition. At the same time, Greece attaches much significance to fishing activities because of the importance of maritime affairs for our country. Greek fishermen today are fishing not only in the Mediterranean Sea, but also in the Atlantic and even further afield.

2. TYPES OF FISHERY

Coastal Fishery (Inshore): operating along the Greek-mainland coasts and islands, especially in areas where fishing grounds are easily accessible to their natural ports.

Offshore Fishery: operating in areas suitable for trawlers and purse seiners, neighbouring with big towns and trade ports. Concerning this type of fishery we must also include fishing operations along the North African Mediterranean coasts, which has been developed since the second world war.

Industrial Fishery: operating in the Central Atlantic and off the west Africa coast. This type of fishery gives fishery products to the greek market that the other two types of fishery cannot.

Sponge Fishing: a special type of industry which produces sponges from Greek and other Mediterranean waters.

3. STRUCTURE AND MAIN CHARACTERISTICS OF GREEK FISHING FLEET

From available data, the Greek fishing fleet, at the beginning of 1987, included 20 228 fishing vessels of various types, with 124 300 t total capacity and 737 900 total hp.

In Table 1 are shown fishing vessels by different types and age, as of 1 January 1987. As can be noted from this Table, 97% of all vessels belong to the coastal fishery and 60% of them are younger than 15 years; they use nets, small trawls and small purse seines, etc.

All of them are small vessels (between 4-13 m) with low power engines.

Table 1

Fishing vessels operating in Greek waters in January 1987

Coastal fishery		Offshore fishery		Industrial fishery	Total
No of vessels	Nets, small trawlers beach-seines	Bottom trawlers	Purseines		
Vessels <15 yrs	11.440	157	144	8	11.749
Vessels >15 yrs	7.914	293	232	40	8.479
Total	19.354	450	376	48	20.228

Offshore fishing vessels make up 3% of the total professional fishing boats, and 30% of the total fishing capacity and power. We can distinguish them into trawlers, purse seiners, or mixed.

Only a small percentage of fishing vessels belong to the industrial fishery, but these are important for their dimensions and production. They are really freezer-trawlers and land fish and crustacea.

4. FISHERY PRODUCTION

In Table 2 is shown the fishery production landed by different types of Greek fishing vessels during the period 1980-86.

As can be noted, total fishery production decreased during the period 1980-83. This is due to the decrease of industrial fishery (no fishing licences could be given to Greek vessels for West African fishing areas), to the limitations of fishing in the Mediterranean Sea, to over-fishing, and pollution.

Inversely to the decrease in fishery production, there has been an increase in the value of fishery production, because of the rise in prices paid for fishery products since 1979.

Coastal and offshore fishery production is estimated to make up 81% of the total fishery catch and also 81% of the total value of fishery products.

Offshore fishery production is estimated to make up 61% of the demand for total production, and its species landings cover the majority of fishery products by the population.

Coastal fisheries concern a large number of fishing vessels but provide much lower levels of landings.

We can notice from Table 2 that there has been an increase in fishery production since 1984. This is due to the increase of landings by the Industrial Fishery, and especially those in Greek seas.

This last increase of fishing activity (in volume and value of fishery production and also in numbers of professionals involved) is proportional to the rise in prices of fishery products which has favoured professional fishermen.

5. FISHING AREAS

The greater part of fishery production, 90-95%, comes from Greek seas. The main Greek fishing areas, concerning their production importance are:

- Thermaikos Gulf and Halkidiki's Gulfs, 22-28%
- Strymonikos Gulf, Gulf of Kavala, Thrakicean sea, 12-13%
- Saronikos and Argolikos Gulfs, 10-11%
- Coasts and areas around Dodekanissa and Cyclades, 10-11%

6. LANDINGS

The greater part of production is landed at several commercial ports. Only 1/3 of the production is circulated among fish buyers.

7. SPONGE PRODUCTION

Production from the sponge fishery during the period 1980-86 is shown in Table 3. Since 1970, Greece has been one of the most important commercial centres for sponge production. Since then, production has decreased as the number of sponge fishing vessels has decreased; these vessels operated in foreign seas, but since 1972 sponge fishing is only carried out in Greek seas. A serious disease affected sponges stocks of Greek waters since 1985.

8. CONSUMPTION

Although fishery production has increased during the last few years, it covers only 80% of market demand; the rest is made up by imported fish products. These imports concern largely industrial products conserved or salted. In the first place among imports there are:

sardines)
tonnes) conserved, and Hake (salted and in fillets)
molluscs)

Except from importations, there exist exports of Greek products as well: mainly mussels and clams, and salted anchovies.

The development of imports and exports of fishery products and their mean value during the period 1985-86 is shown in the following Table:

Year	Importation (tn)	Value (drs.x 10^3)	Exportation (tn)	Value (drs.x 10^3)
1985	45.310	10.156.144	11.809	4.556.067
1986	60.276	15.160.440	13.575	6.760.241

9. PROFESSIONAL ACTIVITY

Today it is estimated that 39 000 persons are involved in fishery activities. During the last two years there has been an increase in the number of professional fishermen. This is due to the restrictions posed on amateur fishing activity and the consequent conversion of "sports" fishermen to professional.

10. TRENDS IN DEVELOPMENT

Although some favourable trends in development of the fishery are evident, there exist important problems:

- shortage of new fishing areas
- no rational management of fish stocks in Greek seas
- difficulties in the promotion of aquaculture
- the age of the main part of Greek fishery fleet and lack of modern equipment
- the insufficiency of fishing ports
- limited research programmes
- lack of specialized fisheries
- pollution problems

Future trends in development must be based on:

- an extension of fishing activities to new areas
- better exploitation of fish stocks by the Greek fleet
- the development of aquaculture in seawaters
- industrialization of over production of pelagic fish stocks.

Table 2

Development of fishery production

Years	1980		1981		1982		1983		1984		1985		1986	
Branches	Produc. in $tn.10^3$	Value in 10^6 drs	Produc. in $tn.10^3$	Value in 10^6 drs	Produc. in $tn.10^3$	Value in 10^6 drs	Produc. in $tn.10^3$	Value in 10^6 drs	Produc. in $tn.10^3$	Value in 10^6 drs	Produc. in $tn.10^3$	Value in 10^6 drs	Produc. in $tn.10^3$	Value in 10^6 drs
I. Sea fishery waters production	110	13.517	107,5	15.504	102	19.028	101	22.480	115,5	29.619	124	39.565	131,5	47.492
a.1. Greek Fishery waters	88	11.141	89	13.172	88,5	16.683	87	19.400	97	29.414	105	34.125	112	40.544
2. Clams	-	-	-	-	-	-	-	-	3	330	2,5	325	2.2	374
b. Open sea fishery	22	2.376	18,5	2.332	13.5	2.390	14	3.080	15.5	3.875	16.5	5.115	17.3	6.574
II. Inland Fishery waters production	7,1	710	8	976	7	1.120	6.5	1.267,5	4,2	1.134	4,4	1.452	4,3	1.720
III. Acquaculture production (S. trutta etc)	2,2	176	2,5	225	2	240	1.9	296,5	1,6	304	2,1	523	2,3	833
Total	119,3	14.403	118	16.705	111	20.388	109,4	24.044	121,3	31.057	130,5	41.540	138,1	50.045

Data from Ministry of Agriculture - ATE (= Agricultural Bank of Greece)

* Fishery of clams up to 1983 is included in Inland Fishery waters production

Table 3

Greek sponge production: 1980-1986 included

Year	Production (tn)	Value (drs : 10^3)
1980	34	95.200
1981	37,4	138.750
1982	38	152.000
1983	32	144.000
1984	29	159.500
1985	32	220.800
1986	33	290.400

APPENDIX/ANNEXE T

An Updated Report on the State of Israeli Mediterranean Fisheries

by

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ABSTRACT

A detailed report on the Israeli Mediterranean Fishery, describing its infrastructure, administrative framework, fleet, catch composition, statistical data collection and data processing methods, and other relevant information has been submitted to the Technical Consultation on Stock Assessment in the Eastern Mediterranean held at Rome, April 1986, and published in the Proceedings of this meeting. The purpose of this notice is to up-date information presented then, especially on points relevant to the Agenda of the present Consultation.

1. THE STATUS OF ISRAELI MEDITERRANEAN FISHERIES

For statistical and administrative purposes, the sea fishery is divided into 3 main-branches: (a) the inshore fishery, (b) the pelagic fishery, and (c) the trawl fishery.

(a) The Inshore Fishery is carried out by 5-10 m long boats with 10-40 hp engines. Many of the bigger boats are equipped with hydraulic handling machinery and, lately, with color echo-sounders. They fish by different types of both floating and bottom set entangling gear and by bottom set longlines. Their operating range is up to 20 miles from shore. The present development is towards bigger boats with more powerful engines. The number of boats in this sector is steadily increasing and imposure of administrative steps to limit their number may have to be taken into consideration in the near future.

(b) The Pelagic Fishery is carried out by boats in the 11-14 m range, with 80-120 hp engines, all of them equipped with power-blocks and colour echo-sounders and some of them, with sonars. They fish small-meshed purse-seines, but also entangling gear and longlines are widely used when pelagic fish are scarce. Because of low prices and lack of demand for pelagic fish, the number of vessels engaged in this fishery is decreasing.

(c) The Trawl Fishery is carried out by 14-27 m. LOA vessels with 180-350 hp engines. All trawlers have hydraulic winches (some also have 2-barrel net-drums), refrigerated fish-holds and an array of electronics including high-performance echo-sounders, radars, VHF and SSB radio telephones and, on some vessels, sonars. Fishing is carried out over all of the trawlable fishing grounds on the continental shelf, using a locally developed four-panel, bottom trawl, "Engel-type" high opening trawls and mini balloon-type shrimp trawls. A new development in this fishery is the introduction of the so called "mini-trawlers"; 10-12 m long vessels, mostly small modified tug-boats, fishing for shrimps in shallow waters near the shore. The number of trawlers increased by some 60% over the last three years. This was made possible by the expansion of the fishing effort over new fishing grounds located by the extensive use of advanced electronic devices and by the diversification and improvements in fishing gear design.

2. FISHERY STATISTICS

Data on the inshore and pelagic fishery are collected more or less regularly at the main fishing harbours at Haifa (Kishon, fishing harbour), Acco and Jaffa. At other landing sites, data are collected by a less reliable sampling procedure. The data thus arrived at including fishing days, catch and catch composition by fishing gear and general fishing area. The value of the catch is calculated from random price samplings by species at the main markets. Lack of manpower dictated by budgetary constraints seriously affects the reliability of the statistical data, but it is estimated that they are accurate within ± 20%.

In the trawl fishery, skippers are required by law to report by radio their position by a grid-system every four hours, and to report the quantity of fish caught every morning for the previous fishing day. They are further required to keep a daily log where all data on the fishing operation, including catches by haul, course, depth, and catch composition are entered. This log is turned over to the Department of fisheries at the end of each month. Compliance with this regulation is not always satisfactory and reported data have to be cross-checked from other sources of information, such as listening into the radio traffic going on between the vessels. Data thus collected are entered into a computerized monitoring programme, by which average catch per fishing hour and by fishing area (the shelf is divided into 11 ecologically different areas), but not on catch composition and catch by type of fishing gear used, can be computed.

In general terms, statistical work is complicated by the lack of accurate information on catches by types of fishing gear; (for example: catches of the various types of entangling gear cannot be separated, and the same is true for high and low opening trawls). Furthermore, catch data from the inshore fishery do not take into consideration the size of the gear deployed, in spite of the fact that some fishing units may set a fleet of entangling gear 500 m long, whereas another may deploy over 2 000 m; or a set of longlines may be made up of anything between 500 to 3 000 hooks. Also inshore and purse-seine fishermen are often not able or not willing to report where the fish were caught. Yet these data are needed to pursue an adequate resources management policy in the light of the increase in number of fishing craft and their higher technological level.

A bilingual (Hebrew-English) statistical bulletin ("The Israeli Fishery in Figures") is published for each calendar year.

3. FISHERY MANAGEMENT AND LEGISLATION

Up to some 2-3 years ago, fishery management was concerned only with the prevention of the catch of undersized commercial fish. This was achieved by enforcing regulations concerning minimum permissible mesh sizes in trawls and purse-seines, and by prohibiting the catch and the marketing of undersized fish (fish which have not yet reached reproductive maturity) of the most important commercial species. The Fishery Administration had no effective legal means of regulating the fishing effort by imposing restrictions on fishermen and on the size and type of fishing gear used. Actually there was no need for such regulations, since generally, resources were underexploited. Management restricted itself to influencing the development of the fishery in the desired direction. The following regulations on minimum mesh and fish size are presently enforced:

cod-end of trawl of any type	48 mm stretched
any part of a purse seine	20 mm "

Minimum Fish Sizes

Sardines of any kind	11 cm
Mullidae	11 cm
Boops boops	11 cm
Sphyraenidae	12 cm
Pagellus erythrinus	12 cm
All other commercially important species	20 cm

It must be noted that the fishermen themselves are not interested in the catch of small fish, as their value on the local markets is extremely low.

Lately, the rapid development of the in-shore and trawl fishery and the appearance of the so called "mini-trawlers" made it necessary to legislate and enforce additional management measures. Thus, an exclusive area for the setting of entangling gear was established, and trawling in this area prohibited. Furthermore, legislation was promulgated giving authority to the Fishery Administration to limit entries into the different fishery branches of additional fishing crafts, to impose certain restrictions on size and type of fishing gear and to establish closed or restricted fishing areas or seasons. Most of these regulations are not yet enforced and much more monitoring of the fishing effort and of the fish resources will be needed to make them applicable.

4. RESOURCES

The main commercial species in the Mediterranean Israeli fishery and their contribution to the total catch by fishing branch is given in the following page: (1986 - in t - rounded figures).

5. RESEARCH AND SURVEYS

Budgetary constraints have seriously limited biological research and planned studies on fish population dynamics. After conclusion of a study of the populations of deep-water shrimps

(Dr M. Tom, results to be published soon) and some research in the dynamics of the population of Merluccius merluccius (S. Pysanti, not yet published), no new projects have been undertaken. Work is presently continuing on the following subjects:

Monitoring of Fishing Effort: the monitoring of the fishing effort in the trawl fishery is continuing into its fifth year. Results are published as arrived at in "Fish and Fish - Breeding in Israel", a Bulletin published jointly by the Department of Fisheries in the Ministry of Agriculture and the Fishermen's Union of Israel (Hebrew with English abstracts). It is intended to extend the monitoring programme to include also the near-shore fishery in view of creating a data base for the regulation of the fishing effort as discussed in paragraph 3.

Trawl Gear Study: a study of the relation between the vertical opening of trawls of different design and catch composition is under way. To this purpose, a cableless net-sonde designed to meet the special requirements of this study is being developed. This device, when perfected, ought to be able to measure the distance between the bottom and the centre of the headline of a trawl to an accuracy of ± 20 cm and not to be affected by the heavy cloud of mud created by the footrope scraping the bottom.

Experimental Longlining: with longlines set on the bottom in depths of 100-400 fathoms are to be continued. In earlier experiments it has been found that large quantities of the deep-se shark Centrophorus granulosus can be caught and the extraction of squalene from its liver may make this fishery a financially attractive commercial operation. Efforts will concentrate on the perfection of a relatively cheap and affordable mechanized gear handling system.

Species	Inshore fishery	Pelagic fishery	Trawl fishery	Total
Sardinella aurita	+ 40	670		710
Saurida undosquamis			100	100
Merluccius merluccius	+		150	150
Epinephelus ssp.	+ 400		50	450
Seriola dumerili	100	50		150
Trachurus ssp.	50	160	50	260
The carangids	100	80	40	220
Argysomus regius	80		50	130
Mullidae	*		550	550
Boops boops	80	180	80	340
Pagellus erythrinus			80	80
Other sparids	250	70	50	370
Lutjanidae	70			70
Scomber japonicus	+ 20	100		120
Erthynus ssp. + Auxis ssp.	250	120		370
Siganidae	300	50	40	390
Sphyraenidae	50	200	50	300
Mugilidae	120	200		320
Solea solea				40
Elasmobranchs	+ 60		60	120
Penaeus japonicus	*		280	280
Parapenaeus longirostris	+		40	40
Others	100	40	160	300
Total	2 070	1 920	1 970	5 960

Note: species marked by + are known to be considerably under-fished. It is estimated that the fishing effort on species marked * should not be increased.

During the last 2-3 years, an unprecedented bloom of Indo-Pacific species (Penaeus japonicus, Saurida undosquamis, Sphyraena tusata, Upeneus mollucensis) has been noted. Also some Indo-Pacific species never before encountered in the catch (Alepes edaba, Scomberomorus commerson) appeared in ever increasing quantities. Although not systematically investigated, the hyphotesis has been advanced that this phenomenon could be attributed to a succession of three exceptionally warm winters, creating a favourable ambient for the reproduction and survival of these warm-water species.

APPENDIX/ANNEXE U

The Selectivity of Certain Trawl Cod-Ends in Cyprus

by

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ABSTRACT

Mesh selectivity experiments on trawl cod-ends, were carried out by the Department of Fisheries in September 1970 on a chartered commercial trawler. The purpose was to estimate the selectivity of two new trawl cod-ends, with a mesh opening greater than the one currently in use by the trawl fishery in Cyprus (32 mm), in order to assess their suitability in the management of fish stocks. Their mesh openings were of 34 mm and 40 mm internal length, when stretched diagonally and measured by an ICES mesh gauge at 4 kg pressure. The covered cod-end and the use of alternate tows were the methods used.

Average selection factor (S.F.) for the 34 mm cod-end for the four species: Mullus barbatus L, Mullus surmuletus L, Pagellus erythrinus L, and Maena smaris L, are in the range of 2.80-3.75 and for the 40 mm cod-end for Maena smaris L and Mullus barbatus L, in the range of 3.40-3.88.

1. INTRODUCTION

The knowledge of the selection properties of trawl cod-ends of various sizes of mesh openings plays a significant role in the rational exploitation of fish stocks, and it is an important instrument available to Fisheries administrators for the rational management of fish resources exploited by the trawl fishery.

The inherent selectivity of otter trawls arises from the ability of some fish to pass through the open meshes of the cod-end during fishing operations. This ability of the fish to escape depends on its dimensions in relation to the opening of the mesh. These dimensions are either the head girth or the maximum body girth in the case of round fish or the breadth in the case of flat fish.

These dimensions are positively correlated with the length of the fish and so the ability of a fish to escape may be dependent on its length, although the dependence is not direct. Thus because of the ease with which fish lengths can usually be measured, it is customary to relate selection directly to length than to any other dimension (Pope, 1966).

Escape of fish through the meshes can take place in any part of the trawl, but experimental evidence suggests that the most important area of escape is in the cod-end.

2. GEAR AND METHODS

2.1 Vessel

A wooden stern trawler of 66.6 ft OAL equipped with 180/210 hp engine and hydraulic winch. This vessel was chartered by the Fisheries Department for a month's experiments in September 1970.

2.2 Fishing Gear

Otter trawlnet of nylon with interchangeable cod-ends of 32 mm, 34 mm, 40 mm internal mesh length openings, knotless, braided. The 32 mm cod-end was the standard cod-end used in the alternate tows. The 34 mm and 40 mm cod-ends were the experimental cod-ends, whose selectivity was tested.

2.3 Mesh Gauge

ICES mesh gauge operated at a pressure of 4 kg.

2.4 Mesh Size

Mesh size of standard and experimental cod-ends used (see Table 2).

2.5 Experimental Methods

The methods used were:

(a) Covered cod-end method
(b) Alternate tows method

These two methods are defined hereunder.

(a) Covered cod-end method

The method of determining the escapement of fish from otter trawls by capturing the escaping fish in a second layer of netting of smaller mesh applied over the primary netting of the trawl. The covering netting is fitted loosely to allow the fish to escape unhampered from the primary netting and usually terminates in a collecting pocket similar to a cod-end.

(b) Alternate tows method

This method consists in tows of trawls in series of two each, the design being such that the two members of each pair approximate each other in space and time as nearly as possible, in order to equalize all factors except a particular difference in the construction or operation of two nets with the object of isolating and measuring the difference.

Two variations are: paired tows, in which the two gears are towed at the same time, often by two different boats; and alternate tows, in which one boat fishes first with one gear variant and then with the other (Clark, 1966).

Advantages and disadvantages of the two methods.

(a) Covered cod-end method

Disadvantages: for this method to give a true measure of selectivity it is essential that the cover in no way affects the relative ability of fish of different sizes to escape from the cod-end. This method has frequently been criticized on the grounds that some fish, which would normally escape from the cod-end if it were uncovered, are prevented from doing so or are deterred by the presence of the cover.

Also the presence of some fish in the space between the cover and the cod-end may affect the escape of others. The flow of water through the cod-end may be greatly reduced if a cover is fitted and this too may reduce escapes. This effect is referred to as masking.

Advantages: the advantage of the covered cod-end method lies in the fact that results are obtainable from single hauls and the actual escapes are observed. In practice the method is a relatively easy one and the analysis of results is straightforward.

It is advisable, therefore that, whenever the covered cod-end method is employed to measure selectivity, to make some hauls with the cod-end uncovered so as to provide a reference set of data from which the existence of cover masking may be detected. This should be done in a properly planned way.

(b) Alternate tows method

Advantages: this is the most straightforward method and the one most free from experimental complications, as both the experimental cod-end and the standard cod-end are used with the same gear fished from the same ship or the cod-ends are used on different vessels at the same time over the same grounds. In the latter case any difference in the fishing powers of the two vessels must be capable of evaluation. The special merit of the alternate tows method is that it is free from any bias caused by the use of a cover.

Disadvantages: because of the haul-to-haul variation in catches a much larger number of hauls are usually required to achieve the same precision of estimation as is given by the covered cod-end technique. A serious technical complication can be the change (usually an increase) in catching capacity of a net with increase in cod-end mesh size (Pope, 1966).

In our experiments no definite experimental design was followed in the order of covered cod-end and alternate tows although such a design existed; but it proved rather difficult to adhere to it closely, on account of the inexperience of the boat's crew in this kind of work and their complete ignorance as far as the importance of the experiments was concerned.

Dimensions, material and mesh size of cover

The cover was of nylon material, 25 ft long, of 16 mm internal mesh length. When attached on the experimental cod-end it extended 7-8 ft beyond its end. Its width was of about 600 meshes.

2.6 Method of Mesh Measurement

The measurements of the opening of cod-end meshes were taken by inserting the ICES gauge in the mesh and exerting a pressure of 4 kg to extend the mesh longitudinally to measure the distance between opposite knots. This is the pressure agreed in European scientific work. All cod-ends were measured in dry and wet condition and after use for some time before experimenting. Details are shown in Table 2.

2.7 Method of Sampling

This consisted of:

(a) specific break-down of a representative part of the catch of each haul, i.e., identification of species, counting and weighing of all fish in the sample separately for the experimental cod-end and the cover, or the standard cod-end and recording the total weight of each haul;

(b) length measurements of the main commercially important species (Maena smaris L, Mullus barbatus L, Mullus surmuletus L, Pagellus erythrinus L) selected randomly from the heap. Length recorded was the total length (LT) from the lower lip to the tip of the upper caudal fin, to the lower ½ cm.

Since the experiments were generally carried out in a manner to approximate commercial fishing practice, the catches were sometimes very large and we were able to meausre only a portion of the fish taken. Thus a sample of the catch was measured, and the length distribution for the catch increased by a representative factor calculated on the basis of the total weight of the catch in relation to the weight of the sample.

3. DEFINITION OF TERMS USED IN THE TEXT

(a) Selection. In reference to fishing gear, the mechanism by which fishes with certain characteristics are captured and others escape; usually in reference to the selection of certain sizes of particular species.

(b) Selectivity. The selection properties of fishing gear; usually referring to the sizes of fish selected by the gear from the available population.

(c) Selection curve. A curve, often sigmoid, fitted to points representing the percentage of fish either retained by the gear or escaping from it at each size interval.

(d) Fifty percent point or fifty percent retention length. The length of fish at which 50% are retained by a particular fishing gear and 50% escape.

(e) Selection range. The range of length of fish between the 25% and 75% retention lengths.

(f) Selection factor. An index, expressing the relation between the 50% point and the size of the mesh involved:

$$S.F. = \frac{50\% \text{ point}}{\text{internal mesh size}}$$

Usually used for cod-ends of trawls; mesh size most often average for whole cod-end.

(g) Cod-end. The terminal portion of an otter trawl in which the catch is retained and lifted aboard, consisting of a long tube of netting of comparatively small cross-section attached to the after end of the belly, which may be opened at its terminus for removal of catch.

(h) Masking effect. The obstruction or partial obstruction of the meshes of a trawl by a cover used for determining escapement, such that fish are to some degree prevented from escaping. Generally any effect of a cover in reducing escapement.

4. RESULTS

4.1 Selectivity of 34 mm Cod-End

The results of experiments with the 34 mm cod-end are shown in Tables 3, 3a, 4 and 4a.

4.2 Selectivity of 40 mm Cod-End

The results of experiments with the 40 mm experimental cod-end are shown in Tables: 5, 5a, 6 and 6a.

4.3 Mean Length at First Capture (L_c)

L_c may be derived from the relation: L_c = S.F. x mesh size and are as follows:

Mullus barbatus:	40 mm cod-end	L_c = 15.52 cm
	34 mm cod-end	L_c = 9.52 cm
Maena smaris:	40 mm cod-end	L_c = 13.60 cm
	34 mm cod-end	L_c = 12.75 cm
P. erythrinus:	34 mm cod-end	L_c = 11.20 cm
M. surmuletus:	34 mm cod-end	L_c = 12.50 cm

5. DISCUSSION

It is obvious from the results of these experiments that the selection factor of the cod-ends is inversely related to the percentage of the fish retained in them, i.e., the higher the S.F. the less is the fish retained in the cod-end.

This relation is clearly shown in the following:

	S.F.	% retained in 34 mm cod-end		% retained in 40 mm cod-end
Mullus barbatus	2.70	70	slight anomaly but not serious	
	2.88	52		
	2.90	57		
	3.47			40
	3.70			30
	4.47			11
Maena smaris	3.5	43		
	4.0	16		

5.1 Combination of Estimates

According to Pope (1966), when several estimates for a particular species of fish and a particular cod-end have been obtained from a series of hauls in one experiment, it will often be desirable to quote a single average value. Thus we get:

Mullus barbatus:	S.F.: 2.80
Pagellus erythrinus:	S.F.: 3.30
Mullus surmuletus:	S.F.: 3.67
Maena smaris:	S.F.: 3.75

The S.F. is also inversely related to the maximum girth of the species concerned, as can easily be observed from the above S.F. for the 34 mm cod-end.

The species having the greater girth, have greater difficulty in escaping than those with smaller girth. In the case of M. barbatus with maximum girth on the head greater than M. surmuletus, it has a S.F. lower than the latter, and M. surmuletus having a girth larger than Maena smaris, has a lower S.F. than the latter.

In the case of Pagellus erythrinus showing a S.F. higher than that of M. barbatus, this cannot easily be explained, unless it could be attributed probably to the possibility that this species is a faster swimmer than M. barbatus and makes repeated attempts at escaping, thus having increased chances in getting through the meshes. Or, most probably this anomaly is due to the fact that this S.F. is derived from only one haul, which makes the result not very reliable.

Comparison of S.F. of 34 mm and 40 mm cod-ends

M. barbatus: 34 mm cod-end S.F.: 2.80
40 mm cod-end S.F.: 3.88

Maena smaris: 34 mm cod-end S.F.: 3.75
40 mm cod-end S.F.: 3.40

The S.F. of 40 mm cod-end for M. barbatus (at 3.88) compares reasonably with the S.F. for 34 mm (at 2.80). For M. smaris the S.F. for the 40 mm cod-end should be higher than the S.F. for the 34 mm cod-end. This is due rather to the fact that the S.F. for the 40 mm cod-end is derived from only one haul for M. smaris.

It is obvious that the number of hauls of these experiments is insufficient to provide us with reliable S.F. for some of the species. Far more hauls are required in any future selectivity experiments, which will supplement the findings of these initial ones.

Of course these S.F. for the 34 mm and 40 mm cod-ends are not truly representative of the selectivity of these cod-ends, taking into consideration the fact of the elasticity of the material, which led to increased length of meshes for both cod-ends at about 15-17%.

6. REFERENCES

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Table 1

Details of hauls

Date	Location	Haul number	Depth fds	Time	Duration of haul	Distance miles	Weight of catch	Codend mesh
	Limassol Bay							
1-2/9/1970	Limassol-Cement factory	1	36-40	02.00-22.30	2.30 hrs	7.5	46 kgs	40mm
1-2/9/1970	Cement factory-Limassol	2	36-40	00.30-04.00	3.30 hrs	10.5	185.5 kgs	32mm
15/9/1970	Limassol-Limnadhakia	3	44	01.45-05.15	3.30 hrs	10.5	64/25 kgs	40/16m
28/9/1970	Limassol-Cement factory	4	40	19.30-23.00	3.30 hrs	10.5	102 kgs	34mm
8-29/9/1970	Cement factory-Limasool	5	40	23.30-02.30	3.00 hrs	9.0	166 kgs	32mm
29/9/1970	Limassol-Cement factory	6	40	02.45- 5.15	2.30 hrs	7,5	102 kgs	32mm
	Larnaca Bay							
3/9/1970	Alyki-Phanari	7	16-20	18.45-20.30	1.45 hrs	5.0	19 kgs	40mm
3/9/1970	Phanari-Alyki	8	16-20	21.00-23.00	2.00 hrs	6.0	51 kgs	32mm
	Episkopi Bay							
16/9/1970	Radar-Zevgari	9	36	21.30-23.30	2.00 hrs	6.0	51/64 kgs	40/16m
21/9/1970	Episkopi-Pissouri	10	40	20.00-22.00	2.00 hrs	6.0	25.5/6.5	34/16m
	Famagusta Bay							
7/9/1970	Profitis Elias-Varosha	11	40-44	02.20-04.20	2.00 hrs	6.0	-----	40/16m
8/9/1970	Profitis Elias-Glossa	12	40-44	02.00-04.00	2.00 hrs	6.0	46/19 kgs	40/16m
10/9/1970	Loukki-Ayia	13	32-40	20.40-22.25	1.45 hrs	4.5	15.5 kgs	34mm
0-11/9/1970	Ayia-Loukki	14	32-40	22.45-00.45	2.00 hrs	6.0	36.0 kgs	32mm
11/9/1970	Loukki-Ayia	15	24-28	01.30-03.00	1.30 hrs	4.5	70.5 kgs	32mm
	Morphou Bay							
22/9/1970	Hospital-Ayia irini	16	44	19.15-23.15	4.00 hrs	12.0	45/13 kgs	40/16m

Table 2

Details of measurements of cod-end meshes used in the experiments

Cod-end	Length mm	Range mm	Mean ± S.E.	No of measurements	Condition of codend
32mm	23,24.25,26.27 1 2 7 4 1	23-27	25.2 mm ± 0.24	15	wet
32mm	25,26,27,28 1 -- 11 4	25-28	27.12 mm ± 0.18	16	wet
40mm	41,42.43 3,17, 3	41-43	42.00 mm ± 0.10	23	New dry
40mm	46, 47, 48 3 15 4	46-48	47.04 mm ± 0.12	22	Wet fished for 2½ hrs
40mm	45, 46, 47, 48 2 19 11 2	45-48	46.38 mm ± 0.12	34	Wet fished for 2½ hrs
40mm	45, 46, 47, 48 1 8 13 5	45-48	46.82 ± 0.15	27	Wet fished for 5 days
34mm	33, 34, 35, 36 6 9 6 1	33-36	34.09 mm ± 0.18	22	New dry
34mm	37, 38, 39, 40 2 2 19 13	37-40	39.19 mm ± 0.13	36	Wet after 8 hrs of fishing

Table 3

Results of experiments by the covered cod-end method

Fig.	Length distribution	Species	Percentage retained in 34mm cod-end
14	34mm cod-end 16mm cover	Mullus barbatus	70%
15a	34mm cod-end 16mm cover	Pagellus erythrinus	70%
16a	34mm cod-end 16mm cover	Mullus barbatus	57%

Table 3a

Results of experiments by the covered cod-end method

Fig.	Selection curve	Species	50% point cm	Selection range cm	Selection factor
14a	34mm cod-end	Mullus barbatus	9.2	8.7-10.3	2.7
15	34mm cod-end	Pagellus erythrinus	11.2	9.7-12.3	3.3
16	34mm cod-end	Mullus barbatus	9.9	8.7-10.9	2.9

Table 4

Results of experiments by the alternate tows method

Fig.	Species	Length Distribution	No of fish	Ratio of fish 34mm/32mm cod-ends
6a	Mullus surmuletus	34mm cod-end 32mm cod-end	83 503	0.16
7	Mullus surmuletus	34mm cod-end 32mm cod-end	83 892	0.09
8	Maena smaris	34mm cod-end 32mm cod-end	68 1068	0.06
9	Maena smaris	34mm cod-end 32mm cod-end	68 2804	0.02
17a	Mullus barbatus	34mm cod-end 32mm cod-end	431 823	0.52
18	Mullus barbatus	34mm cod-end 32mm cod-end	431 421	1.02
19a	Maena smaris	34mm cod-end 32mm cod-end	1224 2859	0.43
20a	Maena smaris	34mm cod-end 32mm cod-end	1224 7713	0.16
21	Pagellus erythrinus	34mm cod-end 32mm cod-end	227 303	0.75
22	Pagellus erythrinus	34mm cod-end 32mm cod-end	227 203	1.12

Table 4a

Results of experiments by the alternate tows method

Fig	Selection curve	Species	50% point cm	Selection range cm	Selection factor
6	34mm cod-end	Mullus surmuletus	12.5	10.9-13.8	3.67
17	34mm cod-end	Mullus barbatus	9.8	8.6-10.6	2.88
19	34mm cod-end	Maena smaris	12.0	11.0-12.7	3.50
20	34mm cod-end	Maena smaris	13.8	12.6-14.2	4.00

Table 5

Results of experiments by the covered cod-end method

Fig.	Species	Length distribution	No of fish	Percentage retained in 40mm codend
4	Mullus surmuletus	40mm cod-end 16mm cover	704 550	0.56
5a	Maena smaris	40mm cod-end 16mm cover	95 213	0.31
10	Maena smaris	40mm cod-end 16mm cover	216 1971	0.09
11	Mullus barbatus	40mm cod-end 16mm cover	598 1391	0.30
12	Maena smaris	40mm cod-end 16mm cover	157 1485	0.09
13a	Mullus barbatus	40mm cod-end 16mm cover	705 1062	0.40

Table 5a

Results of experiments by the covered cod-end method

Fig	Selection curve	Species	50% point, cm	Selection range, cm	S.F.
5	40mm cod-end	Maena smaris	13.7	11.9-14.6	3.4
11a	40mm cod-end	Mullus barbatus	14.7	13.0-15.9	3.7
13	40mm cod-end	Mullus barbatus	13.9	12.3-15.1	3.47

Table 6

Results of experiments by the alternate tows method

Fig	Species	Length distribution	No of fish	Ratio of fish 34mm/32mm cod-ends
1	Mullus barbatus	40mm cod-end 32mm cod-end	226 1957	0.11
2	Pagellus erythrinus	40mm cod-end 32mm cod-end	228 280	0.80
3	Mullus surmuletus	40mm cod-end 32mm cod-end	121 941	0.13

Table 6a

Results of experiments by the alternate tows method

Fig	Selection curve	Species	50% point,cm	Selection range	S.F.
1a	40mm cod-emd	Mullus barbatus	17.9	16.2-18.6	4.47

APPENDIX/ANNEXE V

Nutrient Status in the Aegean Waters

by

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ABSTRACT

In this paper, the content and the vertical distribution of nutrients are compared between stations, in the Aegean, the Ionian and the western Mediterranean Sea. Also the literature on nutrient content in the Aegean Sea is discussed. The lowest nutrient concentrations were found in the Aegean Sea. High nutrients observed in the coastal waters of the Aegean Sea are related to the different sources of nutrients, the morphology of the area and the circulation of water masses. The classification of ecological areas and the assessment of the effects of sewage discharge in the Aegean Sea are discussed.

1. INTRODUCTION

In this paper, some estimates of the nutrient content and the vertical distribution of nutrients in the Aegean, the Ionian and the western Mediterranean Sea are compared between stations, (Figure 1). Also an attempt is made to assess eutrophication levels in Aegean coastal waters (Figure 2).

Attention is drawn to the data from the National Centre and the PASTOUZO cruise. This has been done because in both cases the same methodology was followed for the analytical methods and techniques.

The published studies in the Aegean Sea are limited to a few series of observations made by McGill (1965), Ignatiades (1973), the data report of the PASTOUZO cruise of the University of Washington's R/V T.G. Thompson (cruise 47) in February-March 1970, and the data of the Centre for March 1980.

More systematic work on the distribution of nutrients has been carried out in the Aegean coastal waters, covering a period of about ten years is also referred to (Friligos, 1981, 1982, 1983, 1985, 1986, 1987).

2. MATERIAL AND METHODS

Samples of water were collected seasonally at a grid of stations and at standard depths using Nansen reversing water samplers. For the analysis of nutrients, they were collected in 100 ml polythylene bottles and kept frozen after the addition of mercuric cloride, until analysed. In the laboratory, they were thawed, filtered through a membrane filter and processed on a Technicon CSM_6 autoanalyser. The methods used are described by Friligos (1982).

3. RESULTS AND DISCUSSION

3.1 Relationship of the Aegean to the Rest of the Mediterranean

3.1.1 Nutrient content

The integrated mean values and the depth at each station are presented in Table 1.

Stations 1, 3, 4 which are located in the northern part of the Aegean Sea presented the highest values of nutrients in contrast to stations 12, 13, 14 in Southern Aegean, which showed the lowest values (Figure 3). This richness in nutrients in the northern Aegean Sea might be due to water originating from the Black Sea (Lacombe, Tchernia and Benoist, 1958). Station 14 was selected as a reference in preference to stations 12 and 13, because it has the greatest depth (350 m) and affords comparison wtih the very deep stations 53 in the Ionian Sea, and 54, 55 in the Western Mediterranean (Figure 1). Table 2 summarizes the minimum-maximum and the integrated mean values at the maximum sampling depth of station 14. The relative factors of increase of the integrated mean values at the maximum sampling depth of stations 53, 54 and 55, are presented in Table 3, taking as a baseline the integrated mean values at stations 14 (Table 1).

Phosphate tends to be accumulated at stations 54 and 55 in the Western Mediterranean, while it increases slightly at station 53 in the Ionian Sea. Nitrate increased progressively from stations 53 to 55. All the stations in the Ionian and the Western Mediterranean appear to show about equal silicate levels. It should be noticed that the mean concentration of phosphate (Table 3) in the Ionian Sea (station 53) as a proportion of the level in the Aegean (station 14) agrees with those found by McGill (1965), while those of nitrate and silicate do not. Also, Thomsen (1931) has presented data in the southern regions of all basins and shows increasing concentrations to the westward. He noted however, that "although the quantity of nitrate and phosphate increases considerably as we go from the eastern part of the Meditereranean to the western, yet the quantity of phosphate and nitrate even in the westernmost is less than at the same depths in the oceanic regions". Redfield (1958) pointed out a sixfold difference between the phosphate level of the eastern Mediterranean and that for the Atlantic.

3.1.2 Vertical distribution of nutrients

The vertical distribution of nutrients in the Aegean Sea (station 9), in the Ionian (station 53) and Western Mediterranean Sea (stations 54, 55) are shown in Figure 4.

Nutrient concentrations are increased below 200 m in the Aegean Sea, in contrast to the other stations where this increase occurs below 100 m. This is due to a higher degree of stratification in the Aegean Sea (Miller, 1963) than in other areas. Bumpus (1948) found that the rate of vertical transfer for phosphorus was unusually low in the Aegean Sea, and from this he concluded that enrichment of the surface waters from deep water was not taking place. However, in the Ionian Sea and the Western Mediterranean, Bumpus obtained a good correlation between turbulence and the change in nutrient concentration. Nevertheless, Redfield, Ketchum and Richards (1963) pointed out that the exchange over the sill at Gibraltar withdraws nutrients at intermediate depths, and thus reduces the accumulation in deeper layers. This limits the effectiveness of vertical turbulence as a mechanism of enrichment in the Western Mediterranean.

In all cases the concentration of nutrients below about 500 m are essentially constant to the bottom. Silicate in the upper waters are not so severely depleted as for the other primary nutrients and substantial increases in concentration occur below 200 m.

3.2 Nutrient Relationship in Various Coastal Regions of the Aegean

3.2.1 Eutrophication assessment in coastal waters

The following methodology was applied to assess eutrophication levels in coastal waters. The region under study was divided according to water masses. Integrated mean values were calculated at each station and each area, and combined to give mean values for a specified cruise. At the reference station of the Aegean, typical values of water soluble inorganic phosphate, silicate, nitrite, nitrate and ammonium were 0.12, 1.22, 0.16, 0.42, 0.36 µM respectively.

The mean concentrations for the various depths, areas and cruises were multiplied by the appropriate volume, to estimate the amount of total nutrients held in dissolved form in the examined gulf. The tendency of its water to accumulate nutrients was expressed as a ratio of the total mass of a nutrient to that of background of the same volume. These ratios (Friligos, 1981, 1982, 1983, 1985, 1986, 1987) are represented in Table 5.

Elefsis Bay, the most industrialized area in Greece, showed a tendency to concentrate all nutrients, but especially ammonium (up to 16 times background). Thessaloniki Bay showed the highest values of phosphate, as well as increased values of ammonium, similar to those in the Inner Saronikos Gulf. The northwestern part of the Thermaikos Gulf, Thessaloniki Bay and Alexandroupolis Gulf contained three times as much silicate as background, owing to the contribution of rivers. The eastern Thermaikos Gulf, the Pagassitikos Gulf and the South Euboikos Gulf presented only slightly greater concentrations of nutrients than those of the Aegean Sea. The North Euboikos Gulf displayed a marked accumulation of nitrate and silicate, due mostly to the great depths and underwater springs. All nutrients were present in all areas at levels well above background. The quality of the receiving waters, with respect to nutrients, depended on the different sources of nutrients, the morphology of the area and the currents.

3.2.2 Classification of ecological areas in the Aegean Sea

In order to establish different ecological areas in the coastal waters of the Aegean Sea, we take into consideration the classification system (Table 6), used by Johnston (1973) and Friligos (1974, 1981). Moreover, Friligos (1981) reported that phosphate is a convenient index of organic pollution. Thus, domestic wastes can be tracked longer and farther from their source of input more by looking at the distribution and concentration of phosphate than by using almost any other nutrient (N, Si). Also, we see that the mean inorganic phosphate value was 0.1 µM. This can be considered as the baseline level and is expressed as N.

The values of phosphate (Table 5) occurred in the ranges N-2N, 2N-4N and 4N-10N in samples. According to the ranges found we can then classify the costal waters ecologically as follows:

(i) unpolluted (N-2N), where normal conditions dominate (Kavala, Alexandroupolis, south Euboikos, Pagassitikos and eastern Thermaikos Gulfs);

(ii) between unpolluted and general enhancement (2N-4N), where phytoplankton is richer than in the above area (Saronikos, north Euboikos and western Thermaikos Gulfs);

(iii) between general enhancement and altered ecological balance (4N-10N), where the biomasses of phytoplankton and zooplankton present the highest values (Elefsis and Thessaloniki Bay).

From the classification of the above areas we took into consideration other parameters (chlorophyll-a, phytoplankton, zooplankton and zoobenthos) which were measured in the coastal waters of the Aegean Sea (Friligos and Koussouris, 1984; Riligos and Gotsis, 1987; Güdenberg, 1976; Ignatiades, 1977, 1979; Yannopoulos and Yannopoulos, 1976; Zarkanellas and Bogdanos, 1977).

3.2.3 Assessment of the effects of the sewage

The disposal of domestic sewage into coastal waters without visible effects is more difficult in the Mediterranean Sea than in the coatal waters of most other seas as a result of the extreme oligotrophy found in the Mediterranean. The discharge of untreated sewage effluent into the Saronikos Gulf has changed the character of that body of water from the extreme oligotrophic coditions of the eastern Mediterranean into a regime showing weak eutrophy.

Taking the inorganic nitrogen content as 2 mM in the sewage (Table 4) and a 200 sea water dilution factor, the final concentration would be about 10 μM. This amount of nitrogen would produce a phytoplankton crop equivalent to about 10 $mg.m^{-3}$ of chlorophyll-a (Eppley et al., 1972). Dugdale and Hopkins (1974) estimated the increase in primary productivity in the Saronikos Gulf to about 6.5 times background (33 g C $m^{-2} yr^{-1}$) and the increase in potential yield to the fishery to about 18 times background. The non-linear relationship of these two parameters is an important factor to be considered in oligotrophic waters. It results from the injection of new nutrients into a system running primarily on regenerated (circulating) nutrients. Complete removal of nutrients from the Saronikos effluents would result in the reduction of the fishery yield to about that of nearby Petalion Gulf; an extremely oligotrophic area. Since totally successful sewage field burial and export of nutrients is unlikely, intermediate effects can be expected, but the non-linearity must be taken into account in assessing the impact on the local fishing industry. Moreover, Dugdale (1976) calculated that, if all the effluent ammonia nitrogen were converted to fish flesh, the value would be 500 million dollars per year. Recently, they found that the increased fish catches in the Saronikos Gulf may indicate increased productivity (Papa-Konstantinou, personal communication).

3.2.4 Conclusions

From the nutrient distribution in the various Mediterranean basins and in the coastal waters of the Aegean Sea, we can conclude the following:

(i) the lowest concentrations occur in the Aegean Sea and especially in the southern part in comparison with other basins. This is due to different factors contributing to the supply of nutrients such as (a) contributions from rivers run-off and land drainage; (b) mixing and overturn of the water column by physical processes; and (c) biological regeneration of nutrient material.

(ii) Three layers can be recognized:

(a) The surface waters are characterized by low nutrient concentrations ranging from 0 to about 200 m from the Aegean Sea and from 0 to about 100 m from the other Mediterranean basins.

(b) A zone of mixing exists between surface and deep waters, where the concentration of nutrients tend to increase regularly down to approximately 500 m.

(c) The deep water located from 500 m to the bottom shows little or no change in nutrient content with depth.

(iii) The nutrient content in oligotrophic regions of Greek waters was rather similar to that of the Aegean Sea, in contrast to the polluted locations; no doubt this is related to variations in nutrient sources, and the morphology and circulation of waters.

(iv) The ecological areas of the Aegean coastal waters can be classified as follows:

(a) Kavala, Alexandroupolis, south Euboikos, Pagassitikos and eastern Thermaikos Gulfs: unpolluted normal conditions dominate.

(b) Saronikos, north Euboikos and western Thermaikos Gulfs; here, conditions between unpolluted and general nutrient enhancement exist.

(c) Elefsis Bay and Thessaloniki Bay; a situation between general nutrient enhancement and altered ecological balance prevails.

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Table 1

The integrated mean values of nutrients in µg-at/l and the maximum depth at each station

Station	NH_4-N	NO_2-N	NO_3-N	ΣNi	PO_4-P	SiO_4-Si	Depth
1	0.54	0.47	0.91	1.92	0.06	1.13	180
3	0.46	0.50	0.99	1.90	0.06	1.18	250
4	0.46	0.49	1.02	1.97	0.09	1.11	270
5	0.29	0.28	0.63	1.20	0.07	1.08	220
6	0.54	0.27	0.78	1.58	0.08	0.95	130
8	0.21	0.15	0.59	0.96	0.07	1.11	400
9	0.35	0.17	1.30	1.82	0.08	1.59	730
10	0.22	0.21	0.29	0.71	0.07	0.97	550
11	0.23	0.22	0.30	0.74	0.07	0.94	280
12	0.19	0.08	0.12	0.39	0.07	0.83	75
13	0.29	0.11	0.34	0.74	0.07	0.68	50
14	0.21	0.21	0.26	0.68	0.07	0.90	350

Table 2

Values of nutrients in µg-at/l measured at station 14 in the Aegean Sea, 28 March 1980. A station selected to represent the baseline conditions of oligotrophic waters

Nutrients	Minimum	Maximum	Integrated Mean value
Ammonium	0.13	0.31	0.21
Nitrite	0.07	0.26	0.21
Nitrate	0.19	0.43	0.26
Phosphate	0.06	0.07	0.07
Silicate	0.82	0.98	0.90

Table 3

The variation in nutrient concentration (integrated mean values at the maximum sampling depth in µg-at/l) in the Mediterranean Sea as a factor of increase over level in the Aegean Sea

Component	Aegean Sea St. 14 Max. Depth 350 m	Ionian Sea St. 53 Max. Depth 2,500 m	W. Med. St. 54 Max. Depth 2500 m	W. Med. St. 55 Max. Depth 2500 m
PO_4-P	1	2	5	4
NO_3-N	1	14	18	21
SiO_4-Si	1	8	8	7

Table 4

Nutrient content (N,P,Si) in μg-at/l of rivers
Axios and Aliakmon (February 1976) and of a
composite sewage sample from the Keratsini sewage outfall (March 1975)

Nutrients	Axios	Aliakmon	Sewage outfall
Ammonium	1.94	0.74	1540
Nitrite	0.66	0.21	16
Nitrate	43.67	36.33	108
Phosphate	0.92	0.43	96
Silicate	166.00	37.30	318

Note: The composite sample was made up of 24 hourly samplings

Table 5

Ratio of total nutrient to background nutrients for different gulfs

Area	PO_4^{-3}-P	SiO_4^{-4}-Si	NH_4^+-N	NO_2^--N	NO_3^--N	ΣN	Reference
Elefsis Bay	5.11	4.15	15.80	3.05	7.00	9.67	Friligos(1981)
Western Saronikos Gulf	2.25	2.95	2.50	1.11	6.39	4.00	Friligos(1983)
Inner Saronikos Gulf	2.50	1.39	4.10	1.55	2.60	3.97	Friligos(1982)
North Eyboikos Gulf	2.87	13.20	1.66	0.49	10.20	5.27	Friligos(1985a)
Kavala Gulf	1.80	1.49	1.00	0.51	1.41	1.10	Friligos(1985b)
Alexandroupolis Gulf	1.32	3.28	1.00	0.65	6.21	3.27	Friligos(1985b)
South Euboikos Gulf	1.46	1.41	0.65	0.48	1.17	0.86	Friligos(1985a)
Pagassitikos Gulf	1.02	2.80	2.60	1.25	2.36	2.28	Friligos(1987)
Thessaloniki Bay	5.33	3.35	4.58	3.83	3.88	4.14	Friligos(1986)
Western Thermaikos Gulf	2.09	3.81	2.91	2.40	3.80	3.22	Friligos(1986)
Eastern Thermaikos Gulf	1.18	2.21	1.97	1.53	2.20	2.00	Friligos(1986)

Table 6

Classification of ecological areas
(after Johnston, 1971)

	General enhancement	Altered ecological balance	Weeds and Worms	Stagnation and kill off
Inorganic Phosphate	3N	7N	19N	53N
Plant Growth	X3 (Original spp)	X8 (Selected spp)	X5 (narrow range spp-intermittent)	no persistent growth-possible isolated blooms
Animal Growth	X 2,1 (Original spp)	X 1,3 (Selected spp)	No estimate available	No stable animal communities

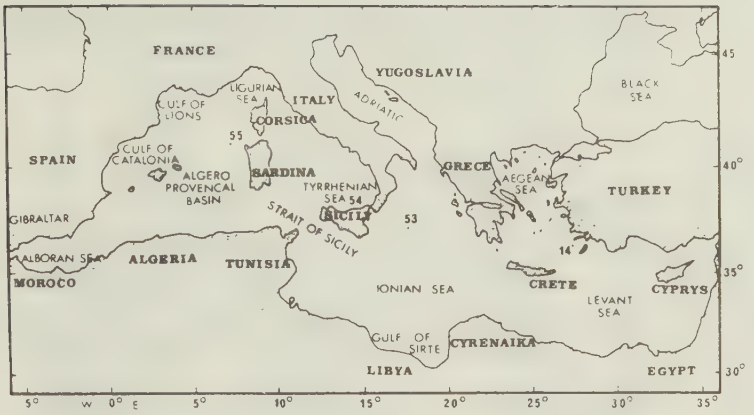

Figure 1 Location of the stations in the Mediterranean Sea

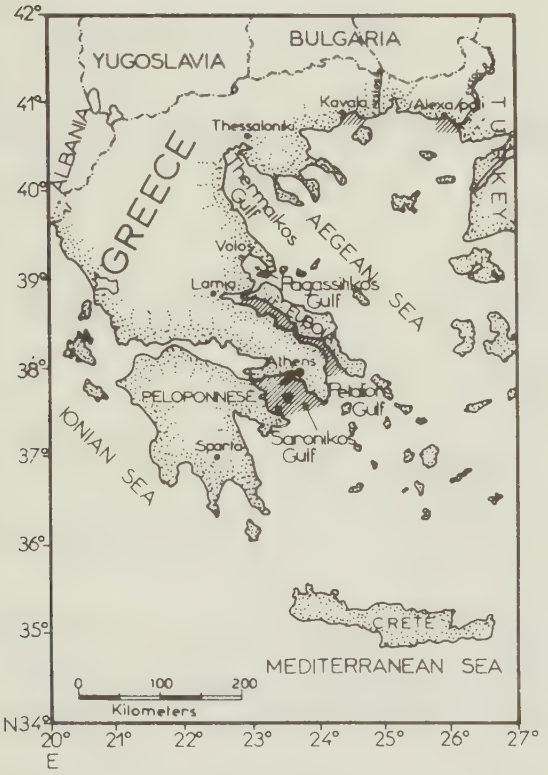

Figure 2 Map of Greece showing the areas compared

Figure 3 Location of the stations in the Aegean Sea

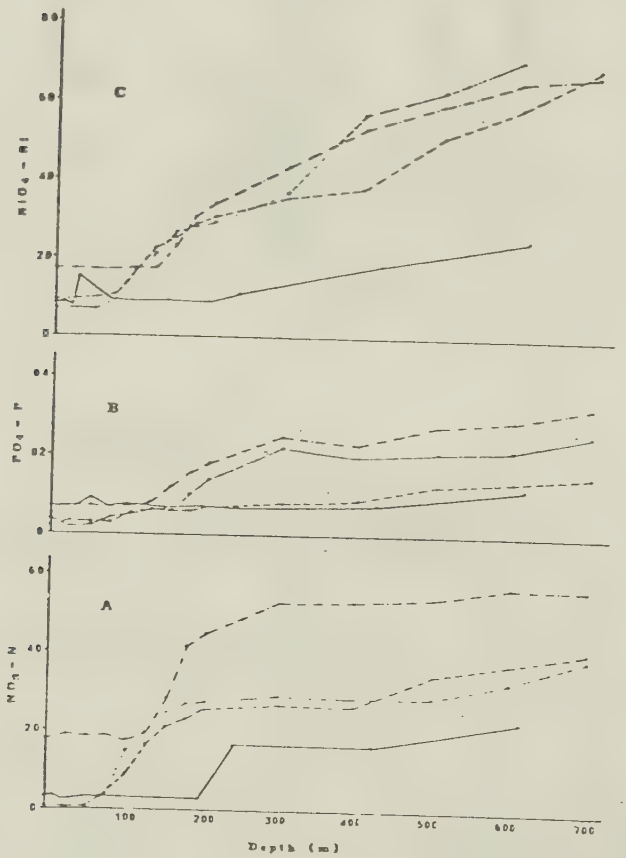

Figure 4 Nitrate, phosphate and silicate concentration in µg-at/l from four stations in the Mediterranean Sea: st.-9, solid lines; st.-52, dashed lines; st.-53, dotted lines; st.-54, dashed and dotted lines. Station depths meters respectively 730, 2500, 2500, 2500

APPENDIX/ANNEXE W

A Note for Fishery Workers in the Eastern Mediterranean on the Estimation of Values for M

by

J.F. Caddy
Technical Secretary, GFCM

The widespread use of Pauly's formulation for M based on von Bertalanffy parameters and temperatures, poses several questions, namely:

(1) What mean temperatures to use for a species that migrates from shallow eutrophic (warm) waters to colder oligotrophic waters at or just before age 1?

(2) What are the best values of K to use in the above formulation? (Those with large negative values for t_o should be regarded with caution).

(3) Why use an indirect formulation if there are age data available, and where catch curves by age can be derived (e.g., Figure 1)? For unfished sanctuary areas, direct estimates of M are in theory possible, as in some Greek waters (see Ricker, 1975).

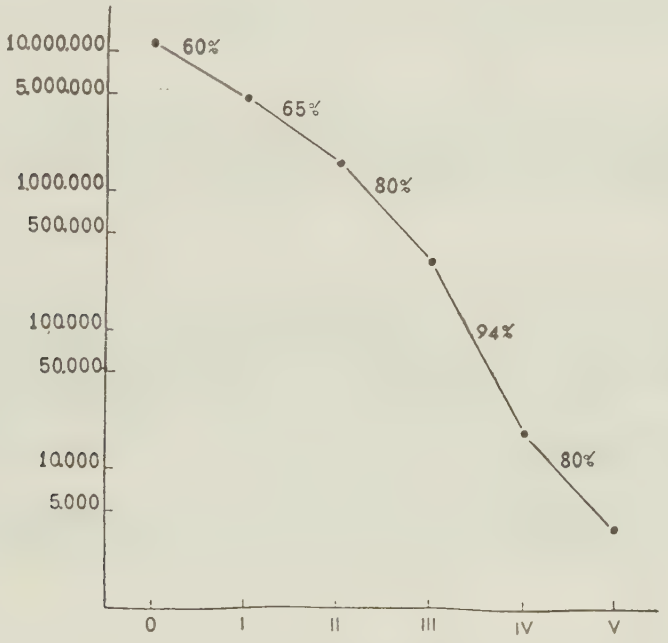

Figure 1 Catch curve (Mullus barbatus) realized from December 1950 - November 1953
(from Larrañeta and Rodriguez-Roda, 1956)

M from mean and median ages and longevity

(a) M from mean age

Several methods of estimating mortality rates from age composition data are now available, most of which stem from Beverton and Holt's original work; for example, that by Holt (1965):

$$\bar{Z} \text{ (= M if no fishing)} = 1/(\bar{t} - t_c)$$

where t_c = mean age at first capture (see Gulland, 1965 for definition)

$\bar{t}$ = mean age of capture.

Hoenig (pers.comm.) modified the above formulation to:

$$Z = \frac{n-1}{n(\bar{t} - t_c)}$$

where n is the number of samples on which the estimate of $\bar{t}$ is based. (i.e., it is probably best to use a large number of samples when working with this equation).

Longevity data and mortality rates

In a separate paper, Hoenig (1983) used longevity data to estimate mortality rates, using:

$$\ln (M) = a + b \ln (t_{max})$$

where t_{max} = maximum age of the 2 or 3 oldest fish in a sample of (say) 200 animals.

Values of a + b developed by Hoenig were:

	a	b
Molluscs	1.23	-0.832
Fish	1.46	-1.01

Hoenig also gives variance estimates for these estimators.

M with age

These approaches all assume constant M with age: it is likely however that M will be higher for juvenile fish, which will need to be taken into account in calculations at or below t_c (see 2nd paper by Technical Secretary; this Consultation).

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APPENDIX/ANNEXE X

Comments on Yield Calculation Presented at Recent GFCM Technical Consultations on Stock Assessment

by

J.F. Caddy
Technical Secretary, GFCM

A number of papers presented at several Technical Consultations of GFCM in recent years have illustrated some of the difficulties and pitfalls of using "short cut" methods of assessment, for example, those based on length data. Some problems are indicated in Csirke, Caddy and Garcia (1987), but it seems worthwhile to expand on some of these in order to assist in improving approaches to yield assessment presented at future consultations.

When preparing such a report the following points should still be borne in mind:

(1) When presenting von Bertalanffy K values as a basis for yield calculations you should be careful of the implications of low values of K associated with large -ve values of t_o if your calculations deal with mesh sizes which catch fish before age 1. Many of the growth curves presented at GFCM Consultations are good fits for size at age of older fish, but often seem to underestimate the growth rate of younger fish.

(2) It may be that the simple von Bertalanffy growth function is not a good description for growth, especially in the first year of life. A series of mean sizes (preferably weights) at ages, beginning in the first year of life could be more accurate (see the "Research Strategy" paper by the Technical Secretary: this volume).

(3) If you feel it is important that a paper including yield calculations be published by GFCM, but where parameter values are not precisely known, I suggest you explore the likely effect of different parameter values on the yield per recruit or yield to be expected from the stock. You may then wish to consider the strategy recommended in the next section.

Effect of Parameter Values on Yield Predictions

Given the problems and uncertainties mentioned above in determining K values and using them to predict changes in yield if you decide to use a simple Y/R approach, it is unwise and even dangerous to use one set of growth and mortality rates in evaluating the yield per recruit curve. These calculations should be performed for a range of values of M and of K (a minimum of 2-3 values of each is a rough "rule of thumb" bracketing the point value you have obtained).

Thus, if you have obtained K = 0.215, M = 0.22, it might be a good idea to calculate Y_{max}, E_{opt}, or whatever criterion you have chosen, for at least the following combinations of values:

Run No:	K value	M value
(1)	K = 0.1	M = 0.1
(2)	K = 0.2	M = 0.1
(3)	K = 0.3	M = 0.1
(4)	K = 0.1	M = 0.3
(5)	K = 0.2	M = 0.3
(6)	K = 0.3	M = 0.3

By using this strategy, you will have a rough idea of the sensitivity of your results for M = 0.22, K = 0.215 to the parameter values used, and will avoid making too many wrong predictions on the basis of incomplete inputs. It is not necessary to include drawings of yield curves in your paper for all of these combinations: (a summary table, or written description will do).

One way of obtaining a better fit to the von Bertalanffy would be by using sizes at younger ages (say 0.25-0.5 years) to force the curve close to the origin. In absence of this data, simply forcing the curve to pass through the origin will at least give you an idea of the upper limit of K, or more specifically, the effective K value that applies to young fish (see later).

I would also like to point to several other methods of obtaining mortality rates that have the desirable property of being independent of the value of K obtained; This is not the case for Pauly's method of obtaining an M value; nor for his approach to catch curve analysis by size for Z, which also use inputs of K values.

Questions of Growth and Mortality: Why Are Independent Parameter Estimates Desirable?

During several recent GFCM Consultations we discussed the problem of using von Bertalanffy estimates with large, negative t_o value for yield/recruit modelling of fisheries which start exploitation early in the life history. This problem has several aspects:

(1) Validating Size at Age Data

If we presume that the first otolith ring is correctly identified, then many demersal fish in the Mediterranean must have a very fast growth in the first year of life. Since for fish like Mullus, where a substantial part of the early life is spent in a semi-pelagic phase inshore, it is apparent why problems have been encountered by early workers in following size frequencies during the first year of life; as a result, validation of the first ring is far from easy. Has this been done for your species? Looking at the daily rings for the first year of life may give clues as to the early growths and help validate the first age mark.

(2) Early Growth Rate

Assuming in the following, that the sizes at age 1 is correctly determined, then judging from several papers on demersal species, close to 1/3 of the total growth in length is accomplished in the first year of life. From the literature, it seems that several of these demersals spend a substantial part of their early life in a semi-pelagic habitat: presumably they are also in warm, eutrophic (nearshore) waters. At some stage around or before the first recognizable annulus is formed, they move to the bottom, and eventually disperse to colder waters offshore: (at least, in the Aegean Sea, these may then be regarded as in an oligotrophic environment). A rapid early growth followed by slower adult growth could be explained therefore, if conditions for growth are more favourable within the first year of life.

(3) Fitting the Growth Curve

The previous comments may explain why many growth curves presented at recent Consultations are apparently good fits for fish older than age 1, but less than satisfactory for the first year of life, with large -ve values of t_o resulting whatever the method of fitting used.

Forcing the growth curve to pass close to the origin is not a statistically recommended procedure, but provides some idea of the von Bertalanffy K values that would be necessary in order to account for the early growth. These values are given in Table 1 for several examples presented in Athens, and Figure 1 shows one of the results obtained.

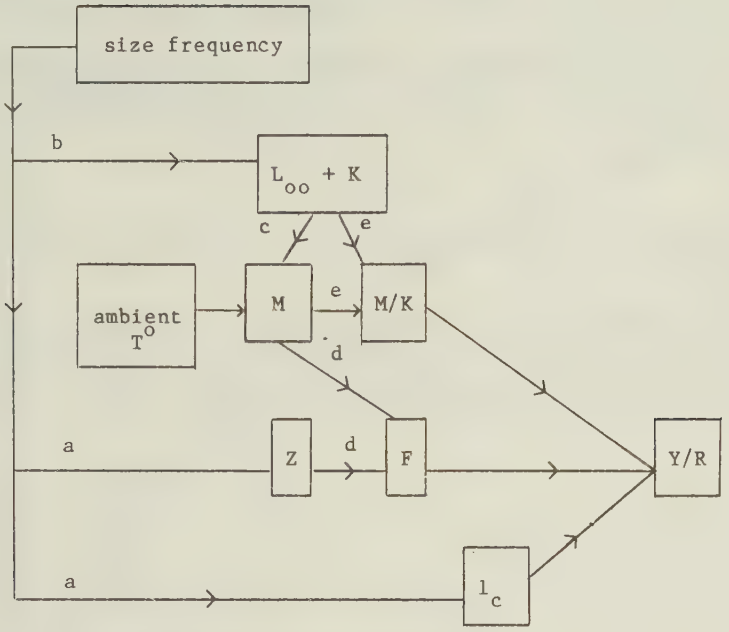
One has to conclude that if the ageing of annulae is correct, a simple, von Bertalanffy growth curve is not a particularly good description of growth for Mediterranean demersal fish throughout its life history; a point made in the research strategy I presented at the Second Eastern Mediterranean Consultation (this volume). It seems that several of the demersal species considered have at least 2 stages in the life history : the first year inshore/pelagic; the remainder, offshore and demersal?

Selection Effects

It may be supposed that for age groups (age 0+, 1?) partially retained by the gear, the apparent mean size would be biased upwards in the catch samples. Thus, the fact that the growth curve when forced through the origin often underestimates L_1, may not be an indication that this is a poor representation of early growth, since the observed mean size of L_1 is probably biased to higher values.

Implications for Yield Modelling

The Beverton 1954 yield per recruit formulation accepts as input M/K values and current values of F in drawing conclusions about fishing strategy. If M is obtained secondarily from K from a multiple regression analysis of published data which incorporates K and ambient temperatures, what are the appropriate values to use? Clearly, in the sequence:



Key to operations:

a: catch curve analysis
b: elefan or modal analysis
c: multiple regression for M
d: subtraction
e: division

- all parameter values derived from this approach depend on K, and as such, are not independent. More seriously perhaps, is the fact that the ratio M/K must be autocorrelated, since numerator and denominator are not independent. The solution to this problem is to use wherever possible, the standard scientific strategy of ensuring that at least the two main parameters, K and M come from independent sources.

Although the following is not intended to provide "correct" values of K, L_∞, it does help to use this approach to see what the upper limits of parameter values would likely be if data were available for $t < 1$ year.

Table 1

Experimental fitting of von Bertalanffy parameters to growth data presented at the Second Eastern Mediterranean Consultation

Species	Statistically Best Fit (1)		Forced thro' Origin (2)	
	K	L_{oo}	K	L_{oo}
Mullus (Cyprus)	0.28	250.6	.48	232
Pagellus (Cyprus)	.20	272.1	1.09	191.2
Pagellus (Greece)	.199	280.1	.73	204.7
Red Porgy(Greece)	.24	400.17	.50	335.0

(1) This procedure is possible, using the Stamatopoulos and Caddy method, (J. du Conseil : in press) by including an arbitrary point close to the origin, with a low age (0.0001 years?) and size (1 mm?), receiving a high weighting, such that the curve is obliged to pass close to the origin (see Figures 1a and b).

(2) Please note again: these results are not presented as an improved estimate of von Bertalanffy parameters for the whole life span. They do however give an idea of the range of K needed to explain early growth.

Conclusion:

The yield per recruit calculations based on the "statistically best fits" in Table 1 might be reasonable, as long as the conclusions are restricted to fisheries which began exploitation after

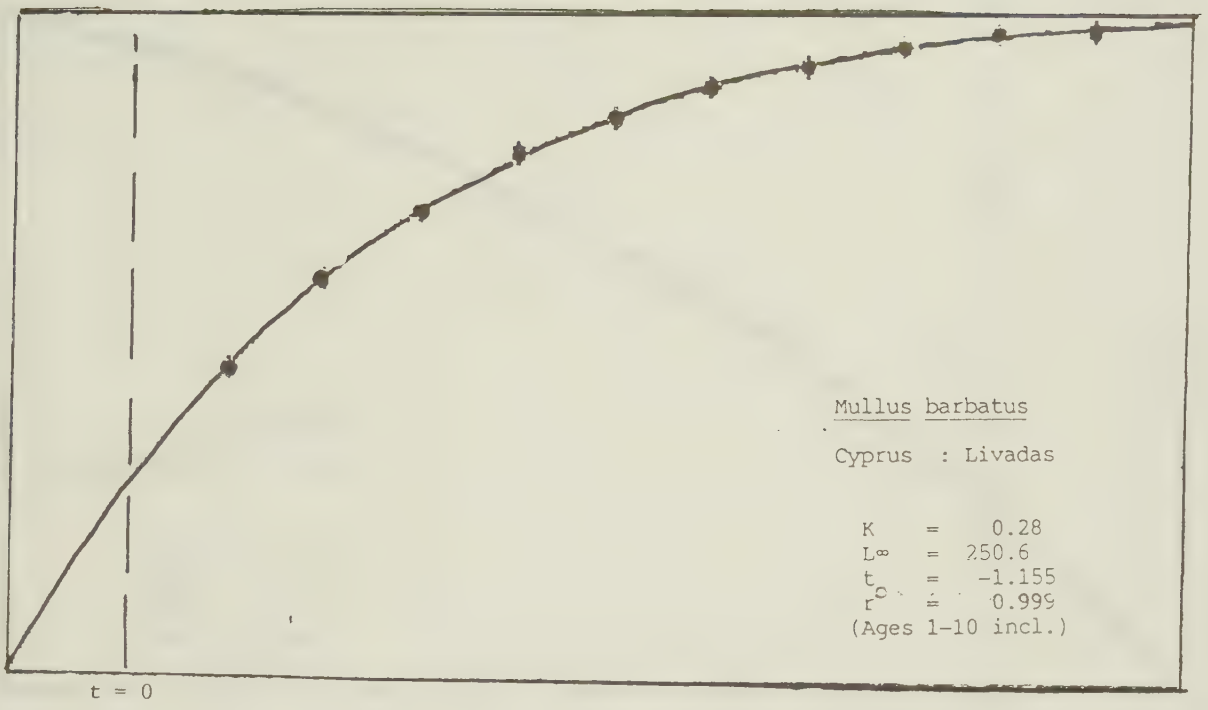
age 1-2, when the growth curve "fits" begin to improve, and not for fisheries that begin at earlier ages of t_c. In fact, the best solution here would be piece-wise integration of yield, as indicated in my "Research Strategy" paper presented in Athens.

In all cases, it would be well to remember that Y/R analysis alone does not say anything about the effects of fishing on recruitment, which can often occur at lower F values than those giving maximum Y/R.

References

Stamatopoulos, C. and J.F. Caddy. Estimation of von Bertalanffy growth parameters: a versatile linear approach. J. du Conseil. (in press)

Csirke, J., J.F. Caddy and S. Garcia, 1987. Methods of size-frequency analysis and their incorporation in programs for fish stock assessment in developing countries : FAO Interest in receiving advice: p.1-6 in D. Pauly and G.R. Morgan (eds). Length-based methods in fisheries research ICLARM, Conference Proceedings 13, 468 p. (ICLARM and KISR)



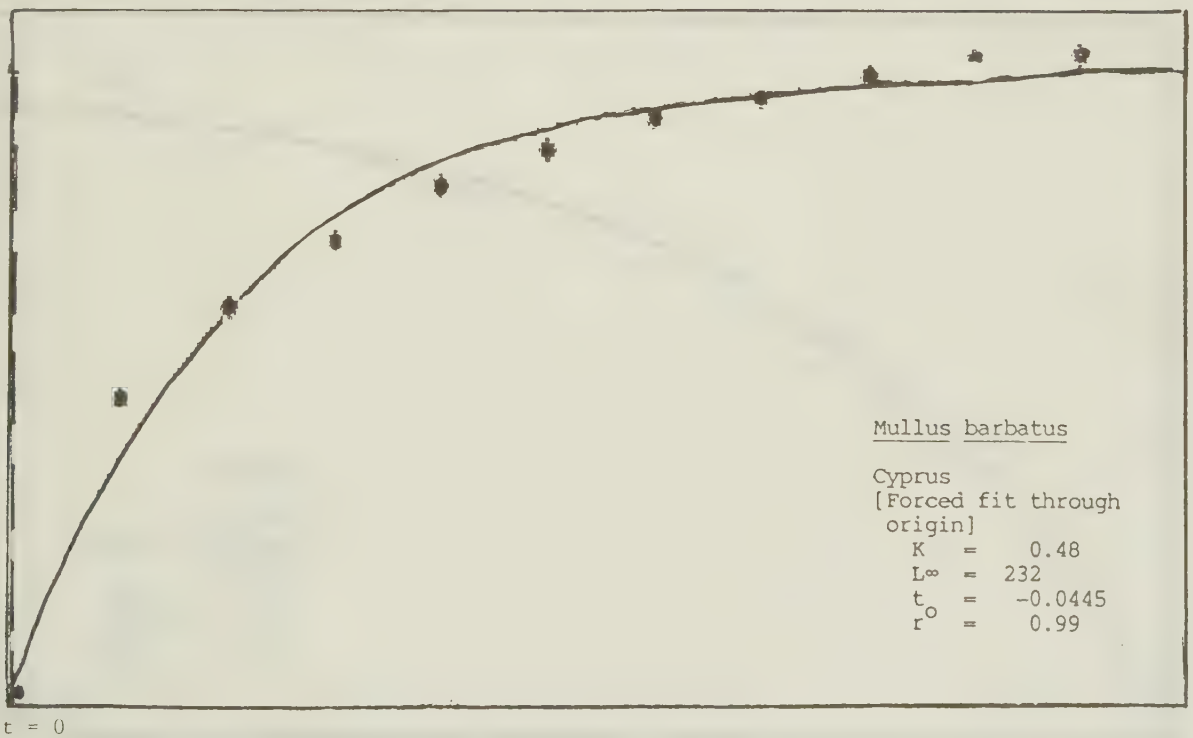
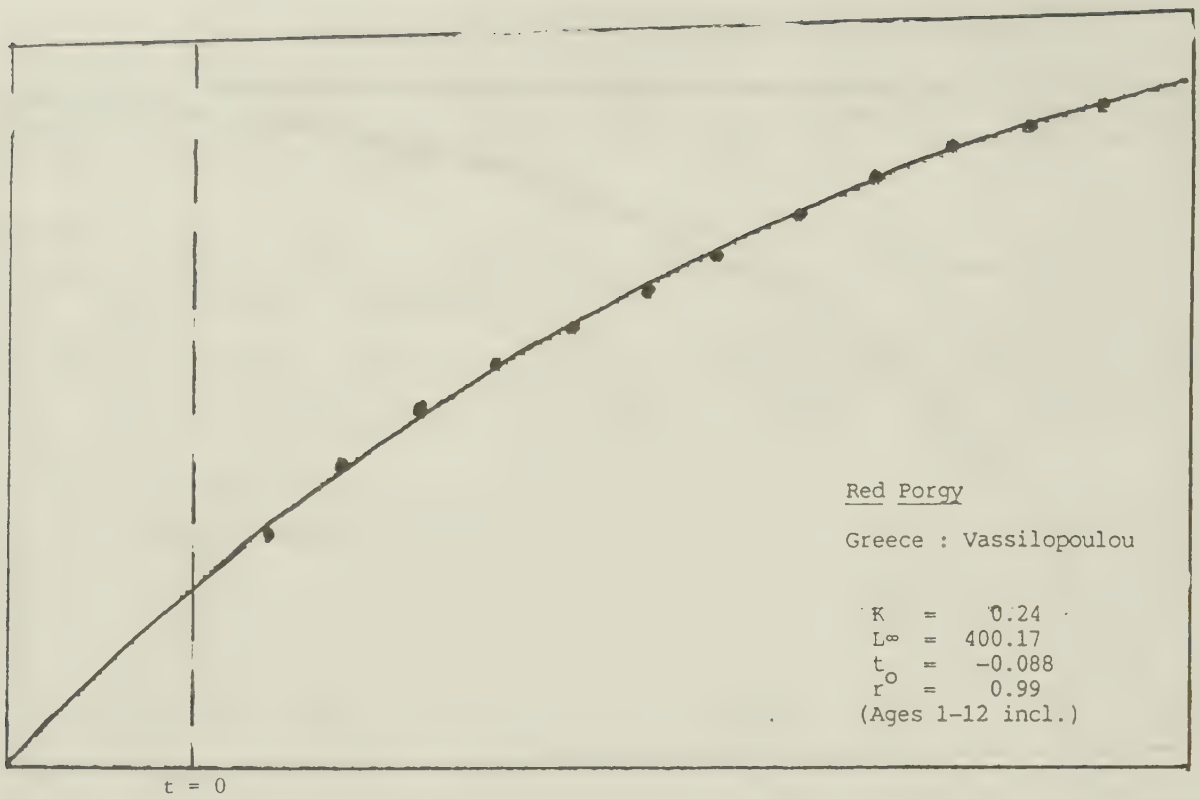


Figure 1a Fits by method of Stamatopoulos and Caddy (in press) to growth curves using (upper) size at age 1 + data (lower) forced fit through origin for Mullus barbatus



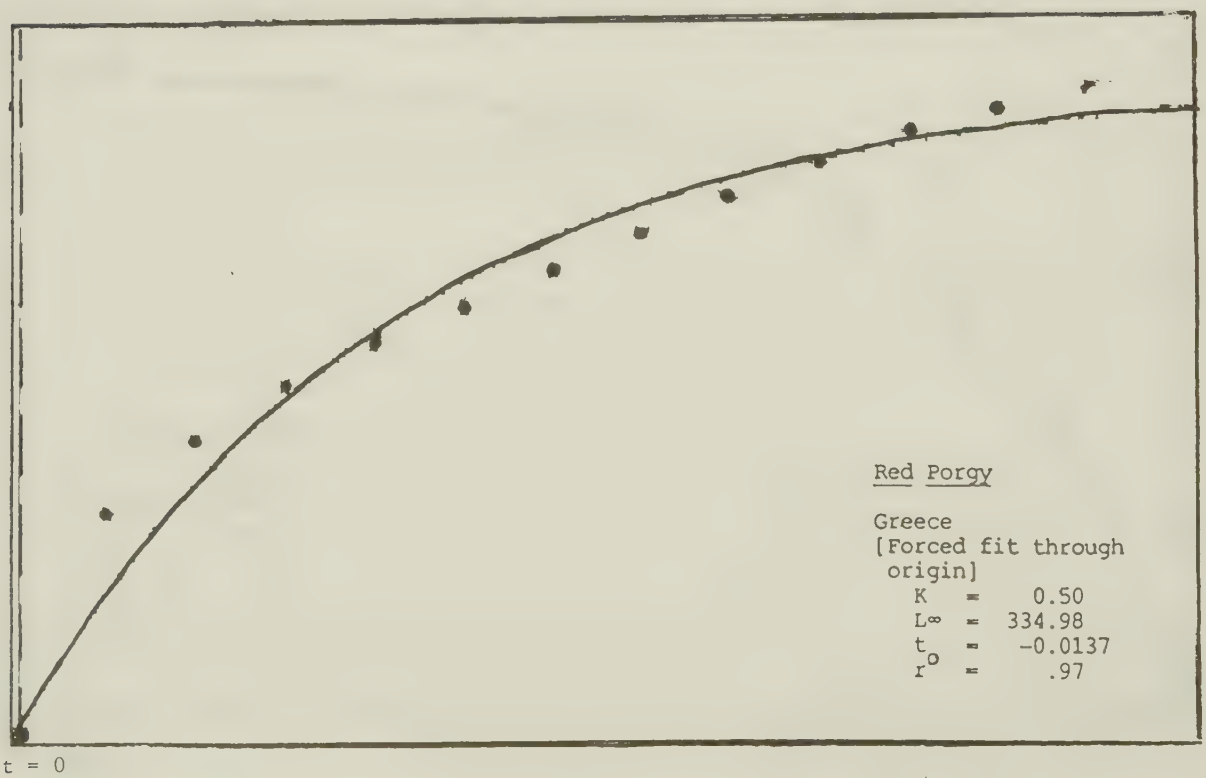


Figure 1b Fits by method of Stamatopoulos and Caddy (in press) to growth curves using (upper) size at age 1 + data (lower) forced fit through origin for Pagrus pagrus

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